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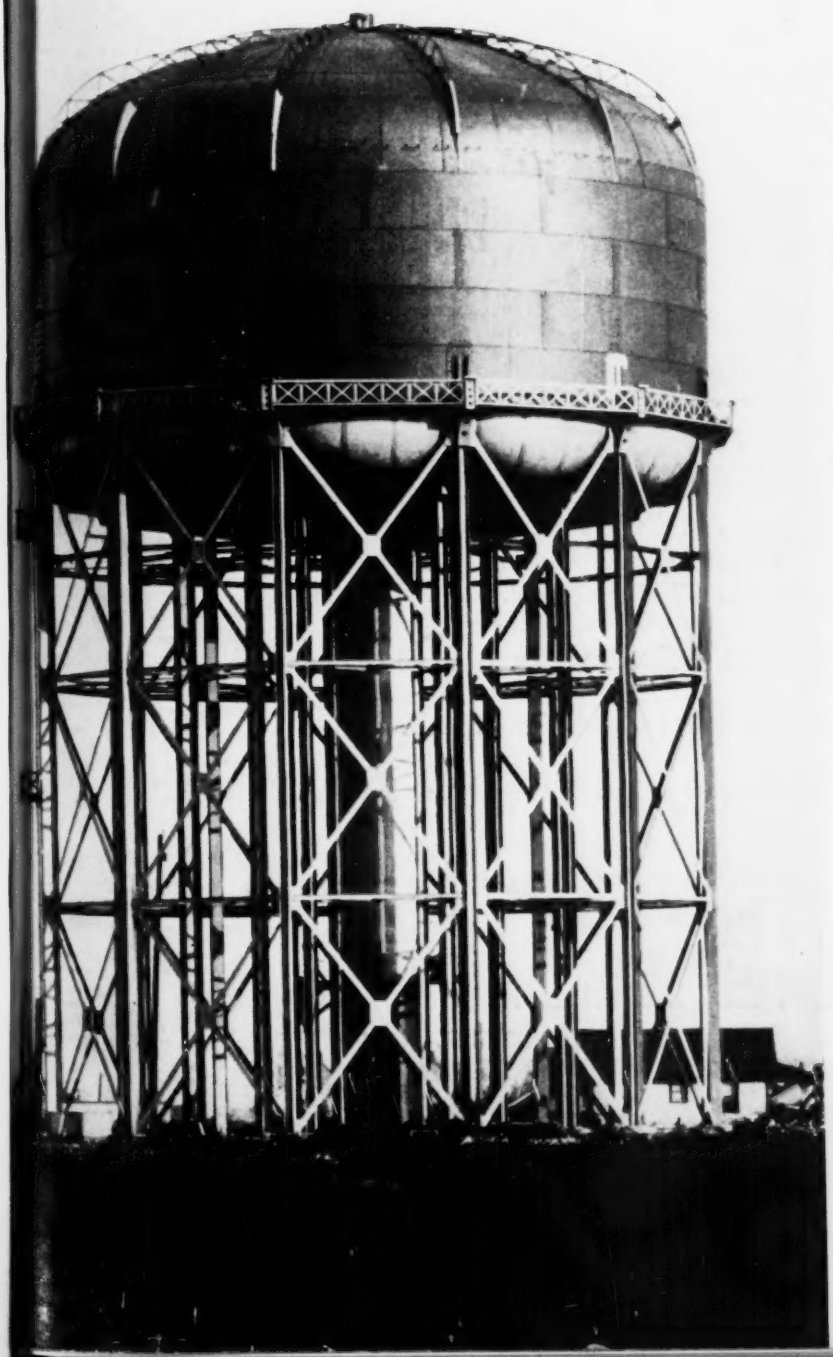

Are Our Cities Bankrupt?

First of a series of articles analyzing the scope and efficiency of municipal improvement operations and their financial background

Also:

Storing Water in a Tank Roof

Controlling Tank Water Level

Earthquake-Proof Tank Tower

Source of Money for Rural Roads

Selecting Wire Rope for Service

Dam Design for Increase in Height

Highway Practices in Australia

Cool-Room Cement Testing in Arizona

Incinerator Fired by Digestor Gas

Sealing a Leaky Reservoir in Italy

McGraw-Hill Publishing Company, Inc.

February 25, 1932

25 cents, $5 per year

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F. E. Schmitt, Editor

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Fickle Nature

SIX feet of snow is reported from the heel of Italy's boot, and weather of unusual severity is general in Europe. At the same instant a traveler crossing the United States finds a most unusual absence of snow, and by and large an unparalleled mildness of weather that has been continuous since the onset of the present "winter." But this abnormality does not stand alone: only eighteen months ago the history-making drought of 1930 began, and last year brought the highest average summer temperatures for some decades. Thus in less than two years we have witnessed a range of unusual conditions of nature that exceeds the usual experience of a generation or two. Perhaps this is nothing more than an odd coincidence. We cannot guess, for weather study has not as yet found any order or rule in natural happenings other than what is already known to all—namely, that balance comes about in the long run. This is not much, but it does serve one good purpose; it emphasizes the need for making our essential services, like water supply, proof against the vagaries of nature, and the no less important need for continuing with all diligence our search for knowledge of the facts. At a time when every effort is being made to reduce municipal and state expenditures, contributions to such essentially continuous work as stream gaging should be maintained at all hazard, in order to rear a foundation for the proper development of utility services.

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Disorganization

DRASTIC cuts in public works have immediate meaning to the individual whom they throw out of a job; their effect on the prosecution of future public work is not so apparent but is none the less serious. This fact is pointed out by Robert Moses, chairman of the Long Island State Park Commission, in announcing that the curtailment of state appropriations has made it necessary to dismiss the greater part of the engineering and architectural staff, over 200 men. It means, says Mr. Moses, the disbanding of one of the most efficient technical staffs ever organized to direct a public undertaking. Through a period of five years the organization has been built up with great care. The Jones Beach development stands as a monument to its intelligence and efficiency. Disbanding the organization now means more than the mere postponement of much-needed work; it means that the staff will be scattered when work is resumed and the benefit of its efficiency lost. The situation is an example of what is to be found in many places throughout the country. The hysteria of tax reduction is causing needless sacrifice of efficient organizations, sacrifice that in the end will cost the taxpayers dear.

Lost Opportunity

ANOTHER disadvantage of the stopping of public work at this time is the loss of an opportunity to lower the general cost of such undertakings by spending now when material, labor and land costs are low, thus offsetting expenditures made a few years ago when all costs were high. It is obvious that many items of public work must be built over a period of years; no community can indefinitely postpone or entirely abandon public construction. When times are good such work is carried out as part of the everyday operations, with little or no thought given to it by the taxpayers. But at such times costs are above the average. When times are bad, as at present, at least the normal public construction should go forward; costs then are down, efficiency of labor and supervision is high, and the work can be carried out to advantage. Tax rates, however, loom up larger in the taxpayer's perspective, and he raises his voice in protest. The result is becoming all too apparent at the present time. Not alone is unemployment increased and public works department organization disrupted but also the public throws away an opportunity to make tax dollars produce most by spending them for needed improvement when all costs are far below the average. Resuming work later will place increased burdens on the taxpayer.

New Products for New Demands

AN example of how engineering demands create new products is afforded by the recent development of the radial-cone-bottom elevated tank, unknown three years ago. Four of these structures are now in service and one is under construction. The particular demand behind their development came about when waterworks engineers in our large cities were forced to extend their systems into remote districts requiring a large amount of elevated storage. Large tanks with the usual suspended bottoms were easily supplied, but the waterworks engineers complicated the problem by the stipulation that

the head variation must be small. Shallow tanks of large diameter were found to be impracticable in the usual suspended-bottom design. Restudy by one manufacturer showed that the flat bottom, long ago discarded as structurally and economically inferior to the suspended bottom, had a possible utility. The final solution was the radial-cone or troughed bottom, which permitted relatively wide spacing of column supports without the penalty of high bottom-plate stresses as in a flat bottom.

Local Preference

LEGISLATION favoring local interests to the ultimate detriment of the public as a whole continues to figure in the day's discussions. New York state is considering at the moment two measures providing local preference to manufacturers and contractors. In comparisons of bids for materials and construction for public use, one bill would deduct all taxes, workmen's compensation and other overhead paid by New York firms to the state in the preparation of the goods to be supplied. Just how even an approximation of such fees could be established for each individual case is not apparent. In the contracting field, under the terms of a proposed contractors' license law, out-of-state firms could do no work within the state, either public or private, for the bill provides that no firm or person shall conduct a contracting business or set up as a contractor without first obtaining a state license; and no license may be issued to any one who does not maintain a permanent place of business within the state. We have often pointed out in these columns the fallacy of local preference; yet it is worth repeating once more that the prosperity of each state and region of the Union depends upon free and unrestricted interchange of goods and services. The two local-preference bills now before the New York legislature, being directly opposed to this principle, merit condemnation.

Full Use of Equipment

DO CONTRACTORS really know how to use modern equipment to best advantage and with maximum efficiency? According to charges made at the recent convention of North Atlantic States highway officials they do not. The charges were backed up by citing experiences on Pennsylvania road construction. Pennsylvania's highway department has been making a study of construction procedure, similar to the study carried out some time ago by J. L. Harrison for the Bureau of Public Roads. As a result, the contractor's average working time exclusive of weather delays has been raised in the state during the past two years from 75 to 82 per cent and in certain cases to 90 per cent of the total contract time. Lost motion and inaction on any construction work come more from lack of coordination of plant operations than from lack of knowledge of operation of individual pieces of equipment. Manufacturers have produced efficient and durable equipment suitable for every construction need. It is up to the contractor intelligently to coordinate and use that equipment to the best interests of each particular job. Pennsylvania is to be commended for the work it is doing to produce more efficient highway construction. While most of the other states have not yet undertaken similar work, many of them are willing to cooperate freely with the contractor in obtaining a smooth-running operation. To the contractor full-time use of equipment means profits. To the state it means more efficient work with a corresponding lower cost to the public. Both parties have a direct interest in seeking to achieve it.

Waterloo Bridge Passes

THE decision to replace with a modern six-lane structure the famous Waterloo Bridge in London affords another instance of necessity finally outweighing sentiment. In this country we have witnessed somewhat similar situations when, for example, river navigation made necessary the substitution of a steel arch for several of the masonry arches in High Bridge aqueduct in New York City, and when a new suspension bridge adequate for modern highway traffic was required to replace the early suspension bridge at Newburyport, Mass. Sentiment dies hard where a structure is a heritage from the remote past. The Waterloo Bridge, famous in its own right as the oldest existing crossing of the Thames, is also notable because its designer, John Rennie, with his contemporary Perronet in France, is the acknowledged founder of the modern bridge-engineering art. Earlier bridgebuilders were clerics or architects who worked by rule of thumb or tradition, but Rennie and Perronet introduced the first semblance of scientific analysis into bridge design. The Waterloo Bridge was John Rennie's most famous masonry structure. It has been criticised for the two Doric columns at the end of each pier, but though these columns may be unnecessary adornment the criticism is petty and hardly deserves to have been kept alive for more than a century. Removal of the Waterloo Bridge may destroy some of the visible evidence of John Rennie's genius, but it can little affect his fame, already assured by many other bridgebuilding exploits, among which was the remarkable 240-ft. cast-iron arch built over the Thames in 1819. And there is still the new London bridge designed by his son and built by his brother in 1931 that inevitably reflects much of the ability of this pioneer bridge engineer. Bridgebuilders of today may not expect their structures forever to resist the march of progress, but building well, they too may count on their names, if not their structures, being revered by generations to come.

Hold to the Facts

MISREPRESENTATION has been regrettably prevalent in discussions of the origin of the large sums which are being spent in highway improvement. The multiple agencies of highway administration, the transfers of funds between states and counties, and the vagaries of distribution and diversion have created confusion in determining the incidence of taxation, and in consequence it is possible to fit the records to almost any bias that the user may entertain or desire to express. As the improved road is in the dual position of a competitor to the railway and a promoter of its own commercial traffic, it offers ample incentive for biased argument. Hence it is not strange that such bias often reveals itself in misstatement and falsification. The engineer, however, has the particular duty of holding his thinking true to actualities.

So that the basic facts may be available for a true appraisal of the present sources of the funds that are providing improved roads, there is published in this issue an analysis by a prominent attorney of the actual records.

To focus consideration on normal practices, the figures have been taken for a year prior to the time when the records were swelled by emergency increase of funds to provide employment in the present depression.

The showing of these figures is clear, and calls for no further explanation here. They make it evident that, whatever regulation and adjustments of highway service may be in order, the payer of property taxes for road-building has scant reason to complain of the burden of highway financing.

Sound reason exists for rationalizing and simplifying our highway taxation practices, and particularly our ways of distributing and applying highway-tax money. Difficult problems remain to be solved in regulating and charging commercial transportation agencies in their use of the highways. Highway officials appreciate fully that present conditions are unsatisfactory. It may even follow that adjustments are warranted to equalize competition between railway and highway. But misrepresentation of the facts of highway taxation will not advance any cause or help solve any problem arising from the condition of flux in which our whole system of highway administration is involved. Let engineering thinking stick to the facts, and let the difficulties be solved in the spirit of engineering, not in the spirit of destructive business rivalry.

City Credit Throttled

WHAT is happening to our cities in the intense financial stringency of today? This question needs answer before municipal services and functions can be discussed quantitatively or qualitatively. On another page is given a survey of the financial condition of various typical cities, as the opening article of the series which we announced last week. Discussions of scope and character of municipal services will follow in later issues. The series as a whole is directed toward two main objectives: (1) to remove misconceptions as to waste and extravagance in municipal government, and (2) to turn the newly active forces which are working for revision of municipal methods into channels where they can do the most lasting good.

Remembering these aims, it is important to observe from this opening article that the present impoverishment of city governments is due not to specific faults of the cities but almost wholly to collapse of the country's money system. Bonds cannot be sold, and short-term money to tide over tax-day intervals is not to be had—that is the simple and pregnant fact. Thus it becomes plain at the very outset that the faults of municipal government are at worst a secondary or tertiary factor in the situation.

Looking at the results of the financial collapse, we see a picture of most alarming kind. Cities great and small, in all sections of the country, are struggling to continue operations with sharply reduced funds. The morale of their employees has been badly shaken. Staffs have been decimated. Salaries are reduced or remain unpaid. Improvements have been halted. Properties are being neglected and valuable facilities left unused.

These evil effects, though due to the money and banking system, yet were accelerated by certain municipal practices. It has been the almost universal custom of cities to spend money before they collected payment for their services in the shape of taxes. Short-term bank loans secured by future tax payments made this possible; and banks, indeed, were by no means hostile to this procedure, for it meant a sizable income for them. But today the security of future taxes on which the practice rested is under a cloud, and since at the same moment the desire for almost complete liquidity of bank funds has risen to astonishing heights, the usual short-term loans are difficult to obtain; even on usurious terms they have been extended only reluctantly.

Tax payments are in a bad way. Delinquencies have increased to the highest point in history. Not only does the average home owner find tax payments at this time very hard, but even those owners who are able to pay look with such ill favor on taxes that some of them deliberately withhold their tax payments. Naturally, then, the banker feels doubtful whether his loans are likely to be repaid promptly. Naturally, also, he seeks to impose conditions on the city in order to make repayment surer; and this means first of all such reduction of city expenses as will make the budget balance.

Balancing budgets these days means not increasing the income but cutting down on the expense side. Moves of this nature are hampered, however, by the number of irreducible items. A large part of the budget is for debt charges, which cannot be cut without destroying the city's credit. Much of the remainder is for mandatory items such as salaries fixed by legislatures for police, fire and school department employees. With so many inflexible items, to make the cuts demanded entails measures that are doing much to cripple the vital service functions of local government. Further, this development comes at a time when greater demands than ever before are being made for unemployment relief funds.

No immediate solution of the dilemma is apparent. Now is the time when sound local governments are greatly needed to maintain healthful community life. They are in danger of being wrecked. Funds are needed but are not forthcoming. When the present pressure is relieved it will be found that the reconstruction of damaged municipalities will cost many times the amount required now to keep them functioning.

In the effort to escape from the dilemma, cities in a number of states, notably Massachusetts, New Jersey and Ohio, have asked for state relief. Some have proposed a state-supported corporation to underwrite municipal credit for tax-anticipation needs. Others have proposed a state emergency board to approve the issuance of city and town notes. These and less specific measures of relief by the state are under discussion. But so far the responsibility of the state for the welfare and soundness of its subsidiaries, the local governments, has been generally ignored. Moreover, heretofore the states have not thought it necessary or proper to take over part of the functions of the banking establishment.

Credit unfreezing is the intent of the measures recently enacted by Congress, and it should tend to ease the severity of the 1932 municipal crisis. Congress has now placed ample means in the hands of the banking establishment, and if the latter lives up to its essential responsibilities those means will become available to permit normal continuance of city operations as well as improvement works. Certain it is that no change in city operating methods—such as tax collection in advance of expenditure—can be accomplished rapidly enough to save the day. The danger is twofold: complete stoppage of public-works construction, and creation of a disastrous tidal wave of unemployment in the ranks of public service, an eventuality that can make an utter wreck of the reconstruction for which everyone is laboring just now.

Are Our Cities Bankrupt? What of Public Works

Many cities have been forced to discontinue public improvement programs because of unpaid taxes and irresistible pressure to reduce expenses

By Frank W. Herring
Engineering News-Record, Chicago

UNPAID TAXES, sarcastically referred to as the "golden assets of accounts receivable," have caused New York, Chicago, Philadelphia and many other cities to take on the appearance of insolvency during recent months. Great difficulties have been experienced in collecting taxes. It has been necessary to appeal—rather than apply—to the money lenders for funds to meet current expenses.

Municipal budgets have been mercilessly attacked by bankers, business men and organized taxpayers, and, although no rational study has been made of the reasons for the present scope of municipal services or their efficiency in operation, the cities have been forced to institute drastic reductions in operating costs. In this process the technical services have suffered most.

Public improvements have been severely curtailed or discontinued entirely. Technical or professional employees have been discharged, reduced in salary or had their pay withheld indefinitely because of empty treasuries. How long the refusal to support the cooperative enterprises necessary for city life will continue is difficult to answer, but while it does there will be damage done to urban civilization from which recovery will be painful and expensive.

This amazing situation, which has burst very suddenly upon the world, is so strange that it can be considered or even understood only by reference to specific facts of typical cases. In the following, therefore, a few such cases are summarized to prepare for fuller study of the problem.

New York's cash runs low

The financial straits into which a community may be thrown when world-wide conditions cut down tax collections and upset the money market is strikingly illustrated by New York City. In January this center of the capital market of the world, which a few months before had obtained short-time money almost for nothing, found itself overnight in such a fix that through its two senators it appealed to Congress for aid. That failing, it speedily met bankers' demands for retrenchments to lighten financing operations and soon had a large credit allowance, though at top interest rates.

Taxes in New York are payable twice a year, May 1 and Nov. 1. It is always necessary, therefore, for the city to be in the market for short-term loans to provide money to pay current operating expenses. These borrowings of operating capital run into hundreds of millions a year, an arrangement by no means disliked by the banks.

SIX QUESTIONS OF THE DAY

1. **Are public improvements too numerous?**
2. **Have we planned them efficiently?**
3. **Do we construct them without waste?**
4. **Do we operate them economically?**
5. **Is their financial basis sound?**
6. **Where can savings best be made?**

These questions are to be discussed in a group of articles.

In addition to these short-term notes, the city finances most of its large public improvements by long-term bonds. The law requires that none of its securities shall be sold at less than par value, so that when it became necessary during the latter part of 1931 to raise money for capital expenditure the city had to raise it by issuing short-term securities, because municipal bonds, along with bonds in general, had declined greatly in value.

When the new year began, 20 per cent of the year's taxes were unpaid, and there was but $23,900,000 cash in the city treasury. And January brought maturing obligations that totaled $55,000,000, of which $37,000,000 was represented by the short-term borrowings for capital expenses.

Although during the past year the city had paid as low as 1⅛ per cent for the money it needed to finance its current expenses, an attempt to borrow $90,000,000 to carry the city through the first month of the year was not considered cordially by the banks.

Banks Impose Conditions—In a conference with the city comptroller, representatives of New York's leading banks stated that marked economies would have to be made in the city's spending habits if its credit was to be considered good by investors. At that time the 1932 budget, totaling $631,000,000, had already been adopted.

One of the items that occasioned much discussion was the budgeted payment for subway construction bonds. The new Eighth Ave. line has been financed in part by a series of four-year bonds so as to reduce fixed charges after operation begins, and thereby make possible a continuance of the five-cent fare. The bankers urged that financing by means of long-term bonds would lessen the annual debt charges to be included in the budget and would thereby ease the city's finances. On the other hand, the long-term financing would probably necessitate a fare increase. The transit items were held to be the heaviest drain on the city's revenue. The bankers gave as their opinion that "the city's ability to borrow money under present conditions rests largely upon the determination of its officials to adopt a strict economy program that will warrant the confidence of bankers and investors that municipal affairs will be handled prudently."

As there were then outstanding $140,000,000 in short-term securities, a substantial part of which would come due within a few weeks, and none of the year's taxes were due for four months, drastic economies in expenditures were apparently called for.

Public Works Curtailed—On Jan. 12 the board of estimate met to consider appropriations totaling $120,000,000 for public improvements. When the meeting was over, projects that amounted to $110,000,000 had been indefinitely postponed, including an appropriation of $78,800,000 for the new Delaware River water supply. On that date the comptroller had $13,000,000 left in the city treasury, and it had become evident that a failure to negotiate a loan would endanger payrolls.

On Jan. 15 the state advanced $15,000,000 out of $22,000,000 due the city for educational purposes.

Securities totaling $27,800,000 came due on Jan. 20. The day before public improvement projects calling for $14,000,000 had been added to the $110,000,000 already on the suspended list. A cut in the appropriation for the board of transportation had forced that department to lay off several hundred men, and it was evident that if its projects then on the suspended list remained there indefinitely it would have to drop almost as many more.

On Jan. 19 a banking syndicate advanced $12,500,000 to the city for eleven days at 6 per cent interest. By using $15,300,000 of its remaining cash reserve the city was able to meet the maturing notes. It was evident that the city was living from hand to mouth. No bills, other than payrolls, had been paid since the first of the year, and on Jan. 15 all day labor had been placed on a five-day-week basis.

On Jan. 20 an agreement was reached with representatives of 34 of the country's banking houses, mostly located in New York City, providing for $350,-

000,000 of credit during the year, if needed, of which $100,000,000 was to be made available at once and $150,000,000 would be provided as a revolving fund. The $100,000,000 loan was half of $200,000,000 of credit authorized by a charter amendment and a legislative bill, both enacted in record time. Immediately the banks supplied $100,000,000, secured by three- to five-year corporate stock notes bearing 6 per cent interest. On Jan. 22 these notes were offered at par and twice oversubscribed within two or three hours—the sponsor banks having reserved to themselves the right to half the issue. The agreement provided that the revolving-fund loans should bear 5¾ per cent interest.

Turning now to permanent indebtedness, this increased from $1,762,000,000 at the close of 1927 to $2,246,000,000 at the end of 1931, after allowing for large bond redemptions each year. New debt, totaling $189,000,000 incurred in 1931, had as its chief purposes $94,000,000 for rapid transit, $31,000,000 for water supply, $40,000,000 for school, hospital and other buildings, $18,000,000 for highways and sewers and $4,000,000 for docks. Debt charges for 1931 aggregated $219,000,000, of which $91,000,000 was for interest and $128,000,000 for debt redemptions, the latter including $50,000,000 to pay off four-year subway bonds. These figures of borrowing leave out of the picture vast totals of temporary loans.

Chicago's complications

Chicago's predicament has the same underlying causes as have upset New York and a number of other cities in borrowing millions in anticipation of taxes—but magnified many fold because of local tax-assessment complications unprecedented in any other city of the world. Its assessments for the 1931 tax year have not begun; those for preceding years had to be made over; and to cap the climax, a recent court decision holds that the 1928 and 1929 assessments are illegal, and therefore those for 1930 and 1931, so far as made.

Presentation of a picture of Chicago's difficulties requires a discussion of the unusual governmental structure of Cook County. Of the many cities and villages in the county Chicago is by far the largest. The present state constitution, dating from 1872, includes a provision that limits the debt of Chicago to 5 per cent of its assessed valuation. Years ago the assessed valuation was defined by law as one-fifth of a fair value. As the degree of financing made possible by this provision proved more and more inadequate, the definition of assessed valuation was modified from time to time. It was first changed to one-third of fair value, then in 1919 to one-half fair value; in 1927 the assessed valuation was made equal to the full fair value.

Meanwhile, however, these sharp limitations on finance led to the organization of supplemental governments to perform specific functions. For example, when the citizens of one part of the city desired a park and found that the city was unable to finance such a development, they organized a park district, a really autonomous government, with debt-incurring powers of its own over and above those of the city proper. Today there are nineteen such park districts, three of them quite extensive. In the same way the Sanitary District of Chicago was organized for the purpose of protecting the city's water supply by discharging its sewage into the Mississippi River instead of into Lake Michigan. As a result, many of those services, which in another city would be rendered by the municipal government, are provided in Chicago by separate municipal corporations, administered by elected commissions, over whose activities the city council has no control.

A municipal corporation is a cooperative enterprise charged with the duty of supplying at cost the services demanded of it. Years ago those demands had largely to do with the maintenance of law and order, the protection of life and property. Today the education, health and convenience of the urban population bulk largest among the demands. Municipal government also has become charged with many technological services that were undreamed of when Andrew Jackson rode his horse over the mountains to Washington. It is those services that have made urban civilization possible.

The school system is in charge of the board of education, over whose activities the council has no authority but whose budget must be met by taxes levied by the city government—as in most of our other cities also. The system is on a pay-as-you-go plan and has no funded debt. The water department comes under the jurisdiction of the city's department of public works, but is financed entirely by water revenue. This department is also largely on a pay-as-you-go plan and, with a book value of $100,000,000 and an actual replacement value of about twice that much, has a total debt of only $10,000,000. Street paving and widening are financed largely by special assessment, and street maintenance is paid for by a municipal license fee for automobiles. Policemen, firemen, street cleaners and other general municipal employees are supported by general taxation from what is known as the "corporate fund."

Faulty Assessment—Until very recently assessed valuations in the county were determined by a board of five assessors and a board of review of three members, all elective officers. The function of the board of review was to adjudicate complaints regarding valuations made by the board of assessors. Under the plan, it was claimed, there was not an equitable geographical distribution of assessed valuations, and personal favoritism was shown.

In 1928 the Illinois legislature recognized the grossly inequitable character of the assessments made for that year and ordered that they be done over. As a result, there was a two-year delay in sending out the 1928 tax bills. During those two years there was no current tax revenue for general corporate purposes, and the city continued to function by means of short-term borrowings in anticipation of tax collections. In 1930 tax bills for 1928 were sent out, but collections came in slowly. Before the 1929 assessment could be completed and tax bills for that year sent out, 1931 had arrived.

One of the provisions of the Illinois constitution is that "all forms of wealth must be assessed equally," implying that personal property should be assessed on the same basis as real estate. When the 1928 assessment was completed and tax bills sent out, it was found that real estate was bearing nearly all the cost of government. Owners of real estate were disgruntled and were welded into some semblance of organization in various communities with the object of protesting their taxes. This movement grew, and there gradually developed a "tax strike."

Two Years Without Revenue—Expenditures continued at a rate faster than revenue was coming in, so that the amount of floating debt in the hands of the banks, represented by tax-anticipation warrants, continually increased. Early in 1931 the general country-wide credit stringency added another factor to the situation. The banks evinced less and less desire to purchase more tax warrants.

In April, 1931, there was a payless payday for the school teachers, but the schools continued functioning with an unpaid staff. The next month, still with no revenue, the school employees were paid in scrip. When the end of the school year arrived, the board of education was in debt some $10,000,000 to its employees.

In August the Sanitary District had to accept a bid of 95.49 for $1,680,000 worth of bonds to finance its construction program made mandatory by the U. S. Supreme Court. In November, when the sale of $400,000 worth was attempted, no bids were received at all. On Nov. 15 the district was forced to suspend payment to its contractors, and all contract work was stopped. On the same day the district's employees failed to receive their pay checks, which allowed obligations maturing on Dec. 1 to be met. Only one-half-months' pay has been received by the employees since that date.

Sanitary District Defaults—With no revenue the strain became too great; on the first day of 1932 the district defaulted on its obligations, when $1,519,000 in principal and interest fell due. On Feb. 1 a second default on $469,000 of bond interest occurred. On that day 200 employees were laid off, most of whom had been engaged on work supported by bond issues. Construction work was at a standstill. The market for the district's bonds had dried up completely.

The root of the trouble lay in the inability of the taxing system to assure an equitable assessment. A conference of prominent citizens had been called by the governor and had studied the case all summer. It recommended that the assessing system be completely revised to provide for centralization of responsibility. In November a special session of the legislature was called to enact into law these recommendations.

On Jan. 1, 1932, 20 per cent of the 1928 taxes was still unpaid, 30 per cent unpaid for 1929, the 1930 taxes had not yet been put into collection, the 1931 assessments had not yet been made, and 1932 assessments were in the dim and distant future!

During the first week of the new year a county court, in rendering judgment in a case brought by a real estate owner, decided that the 1928 and 1929 tax levies were invalid because the constitutional provisions for the inclusion of personal property in the assessment had been only scantily fulfilled. The effect of that decision is that no legally binding assessments have been made in Cook County since 1927.

There is $230,000,000 worth of tax-anticipation warrants unredeemed, $97,000,000 of which are in various city funds in place of cash. There is $20,000,000 owed to teachers, including the $8,000,000 worth of scrip the teachers have accepted. No employee of the city has been paid since the first of the year. No money can be raised from the sale of tax-anticipation warrants, and no taxes can be collected because of the non-existence of a legal assessment.

Assessment System Remodeled—On Jan. 21, 1932 (*ENR*, Feb. 4, 1932, p. 193), the legislature passed a compromise bill providing for the reorganization of the assessment system. There is to be a single assessor and a board of review of two members, one of the latter appointed by the governor of the state and the other by the president of the county board. These reviewers are to select the assessor and can override his assessment only by voting together. It is now hoped that assessments can be made that will stand judicial scrutiny.

Philadelphia's own bed

Philadelphia is afflicted with troubles largely of its own making. For years the tax rate fixed by the city council has been insufficient to meet operating expenses and each year has ended with a deficit. At present the deficit is too large to be disregarded, but taxpayer pressure has been sufficiently strong to prevent the council from raising the rate; as a consequence, insufficient revenue, now aggravated by serious tax delinquencies, is threatening the continued operation of the muncipal services. The bonded debt limit has been exceeded and, the city being unable to market bonds for permanent improvements, public works will probably be discontinued for a year or two.

Philadelphia's budgets have been unbalanced since 1921. For the last few years the deficits have been as follows: 1926, $3,461,161; 1927, $6,778,271; 1928, $3,645,904; 1929, $7,334,460; 1930, $6,530,293. Official figures for 1931 are not yet available, but it is now estimated that the budget deficiency will be about $17,500,000.

When tax bills, which are charges for the services rendered by the municipality, are not payable until some months after the service year is over, the city is, in effect, extending credit to its customers. That credit is expensive and hazardous because it must be obtained by borrowing from the banks. Unpaid taxes must be considered as bad accounts by the banks and make it increasingly difficult and expensive for a city to obtain its necessary working capital. Any city, like any business, can be financially embarrassed by a too generous credit policy toward its customers.

In addition to the general-fund deficit, carried as a floating debt, there is a large amount of floating debt occasioned by mandamuses for land condemnations and damages to property, mortgages on city property, awards and claims against the city not yet represented by mandamuses, and unpaid vouchers and bills. At the end of 1931 this additional floating debt totaled more than $21,000,000. Last year funds for unemployment relief were obtained by borrowing $3,000,000. That loan now represents a first lien upon the revenues of 1932. There was also a special loan of $3,000,000 for policemen's and firemen's salaries authorized on the same basis.

The long series of unbalanced budgets acted to the disadvantage of the city when it tried to sell an issue of $15,000,000 of 4¾ per cent bonds in October of last year. The bankers refused them. On being offered "over the counter," they sold slowly until a few days ago when the city controller had to stop the sale because the debt limit was being approached. Part of the difficulty is due to the low interest rate, as some of the city's seasoned bonds are now selling in the open market to yield 5.3 per cent. Further, the bankers are insisting that the city balance its budget.

When the time came for fixing the 1932 tax rate the city council proposed a heavy increase over 1931 (35½c. per $100) to make up for past deficiencies and provide for current needs. So strong was the taxpayer protest that the council yielded and again adopted the old and inadequate rate. Consequently the year 1932 began with a hopelessly inadequate budget, carrying a large deficit from last year. As a consequence almost all budget items except those for interest, sinking funds and state tax on the bonded debt have been seriously cut. Since the first of the year, 1,300 employees have been laid off. More will undoubtedly follow. Merchants supplying the city with goods are being made to wait a long time for their money—some more than six months. The art museum is open only four days a week and the library is being operated on reduced time.

The total budget items for each department have been greatly reduced, but as yet no decision has been made as to what services are to be curtailed. Protests at plans to reduce the salary of policemen, firemen and pary guards have been sufficiently strong to prevent any curtailment there. Employees in many other positions claim that their salaries are inviolate, being fixed by the state legislature.

Toledo also cuts improvements

Financial embarrassment has not been confined to the largest cities of the country. Toledo, Ohio, is in a bad way and has largely discontinued public improvement work since the first of the year. Further, it has sharply curtailed the maintenance and operation of the facilities it already has and has severely reduced the salaries of municipal employees.

Toledo's troubles are more closely tied up with the general business depression than are those of some other cities. In August, 1931, there was an epidemic of bank failures in the city, and when the summer was over only two banks were open for business. Four others had had to close, impounding more than $3,500,000 of the city's deposited funds. At the same time the unemployment problem was steadily increasing in severity, and expenditures for relief purposes were mounting far beyond what had been expected.

The closing of the banks had a two-fold effect on the city's finances: a large part of its funds was frozen, and tax collections were rendered extremely difficult. The deposits in the various banks had been guaranteed by bonding companies, but when the guarantees were invoked the companies, because of a recently completed merger of two of the banks that had failed, were unable

to agree among themselves as to their proportionate share of the liability. The law provides that the guarantees must cover the deposits to the extent of 110 per cent of their value, but it became the duty of the city to bring suit against the bonding companies to end their disagreement. At the end of the year about half the deposits had been made good; repayment of the remainder still awaits the action of the court.

On the other hand, the impounding of private funds in the defunct banks made tax payments virtually impossible for many individuals. This has been the case especially with numerous large trust-fund properties, ordinarily large taxpayers. At the end of the year tax collections in Lucas County were 16 per cent delinquent, much more than had ever been the case before.

While the city's available funds were sharply reduced by the freezing of assets and by tax delinquencies, expenditures for "poor relief" mounted steadily. In 1929 only $65,000 had been necessary for this purpose, but 1930 required $500,000, and 1931 more than $1,000,000. The year 1932 started off with unemployment relief curtailed in large measure but still costing more than $110,000 per month. Expenditure for relief purposes now assumes the most important rôle in the city budget.

No Market for Bonds—In October, 1931, the city offered for sale $1,300,000 worth of short-term special-assessment bonds for public improvement work, but there were no bidders. In December the same amount was offered again, this time with a 6 per cent interest rate, but still they could not be sold. But the improvements they were to finance had already been constructed, paid for out of funds received from the sale of bonds for other purposes. An immediate and drastic reduction in operating expenses and a complete discontinuance of all special-assessment improvements became imperative.

A change in administration took place on the first of the year. The heads of the various city departments were not retained, and as yet no successors have been appointed for many of them. There is no city engineer, no commissioner of health, finance director, auditor or purchasing agent. No paving or water-line construction and only one small sewer job are under way in the entire city. A grade-separation job, however, is to be started in a short while, as it is financed by general faith and credit bonds that were sold in November. The brand new sewage-treatment plant remains unoperated, largely because of the city's unwillingness to incur the operating expenses. Consideration is being given to the abandonment of the garbage-incinerator plant and contracting for the collection and disposal of garbage and refuse. The force in the city engineer's office has been reduced from 56 men to 15; at one time it was down to 6. A general cut in salary of city employees has averaged 25 per cent.

Others in the same boat

What New York, Chicago, Philadelphia and Toledo have experienced in raising money for even current needs is matched in other communities.

Gloucester County, N. J., served notice Feb. 18 on three boroughs and five towns that they must pay taxes past due the county. To carry on meanwhile, a resolution to borrow $25,000 was adopted before it was found out that the county's borrowing capacity was only $4,800.

A striking case is that of Campbell, Ohio, a steel-town suburb of Youngstown. On Feb. 7 its employees had not been paid for five months, it had defaulted recently on $51,000 of bonds; large bills were unpaid; its deficits at the end of 1932, including earlier tax delinquencies, promised to be $265,000.

The largest city in Ohio, Cleveland, has been struggling to balance its budget. As one means to that end it has made 5 to 20 per cent salary cuts. Entire closing of the public library May 1 is foreseen unless banks will loan money to carry on until tax money comes in. Columbus is reported to have balanced its budget by making 30 per cent cuts in appropriations and abolishing positions. St. Joseph County, Ind., has abandoned its 1932 road-construction program.

Several cities other than Toledo have been crippled by bank failures, notably Asheville, and other local units in Buncombe County, N. C. Lawrence, Mass., suffered in December from the failure of two banks in which was deposited $750,000 of its funds; bills and payrolls could not be met for a time, and on Feb. 1 some 1,500 employees went unpaid—the first incident of the kind in the twenty years of the charter. West Orange, N. J., had to renew several notes because some of its funds were tied up in a local bank that closed Jan. 14.

In New England a prominent bond default is that of Fall River, Mass., which through bad financial management over some years was unable to meet $2,100,000 tax-anticipation notes on Nov. 4, 1930. Further trouble following, the local banks induced the legislature to create a board to take charge of the city's finances for ten years, with authority to issue $3,500,000 ten-year serial bonds to meet outstanding obligations and to sell $1,000,000 of refunding notes to cover unpaid taxes.

Bonds goes begging everywhere

From coast to coast cities of all kinds have found that they could not sell either bonds or short-term notes. A typical list pictures the situation and brings out that breakdown of the financial system is at fault, rather than city extravagance.

Bridgeport, Conn.—No bids late in December on $200,000 of improvement bonds.

New Haven, Conn.—Rather than pay 6 per cent in the market early in January, city borrowed $300,000 from its bond-redemption fund.

Buffalo, N. Y.—No bids Feb. 11 on $4,790,000 bonds and short-term notes, although the bonds alone ($1,790,000) could have been sold.

Southold, N. Y., School District—No bids in mid-February on $550,000 bonds, although bidders could name interest rate up to 6 per cent.

Elizabeth, N. J.—No bids dec. 28 on $5,000,000 of 4½ per cent water bonds, but on Jan. 20 sold $500,000 at 5½ with option to take remainder.

Kearny, N. J.—Incinerator construction halted early in February because of inability to make contract payments.

Passaic, N. J.—No bids late in December on $2,000,000 tax-revenue bonds.

Paterson, N. J.—Finance board decided in February that unless it could market city paper promptly it would be offered "over the counter," in denominations to suit buyers.

Pittsburgh, Pa.—No bids Jan. 13 on $420,000 of 4½ per cent public-works securities.

Baltimore, Md.—Rejected single bid at 84 (5 per cent yield) on $4,200,000 long-term improvement bonds; later sold the issue at 86.75. On Sept. 17, 1931, had bid of 106.877 on a 4 per cent issue.

South Carolina (State)—Cancelled sale of $10,000,000 highway certificates, due July 15, 1932; intended to re-offer when market better but subsequently notified contractors to choose between waiting for money or shutting down work until ordered to resume.

Birmingham, Ala.—No satisfactory bids Dec. 11 on $1,130,000 bonds. Jan. 19, city sinking fund bought $130,000 drainage bonds to repay money advanced from city's general funds for emergency relief work, but failure to sell remaining $1,000,000 will bring all emergency-relief drainage work to end in four months.

Akron, Ohio—No bids Jan. 5 on $800,000 of 6 per cent 1933-52 improvement bonds. Later dismissed all engineers in street and sewer construction. Prospect is that nearly $3,000,000 notes will go unpaid until bonds can be sold.

Fort Worth, Tex.—There being no market for bonds at "reasonable rates" and $900,000 of overdrafts in general, interest and sinking funds council took under consideration Feb. 9 indefinite suspension of all projected improvements, except viaducts for grade-crossing elimination, subject to railways taking bonds for city share.

Houston, Tex.—In January banks declined additional loans until assured city will have revenues to meet payments. Local bank clearing-house studying city's financial condition. All pending improvements suspended until status of each determined.

Seattle, Wash.—Employees of municipal railway system may strike; are holding $112,000 warrants that banks refuse to accept. Authorities say warrants can be paid March 10 if railway can be kept going until then. Revenues being impounded to pay $235,000 bond interest due in March. On Feb. 5 no bids for light bonds for Skagit River work.

Sacramento County (Calif.) School Districts—No bids at end of December on $1,146,000 of 4½ per cent school bonds.

Los Angeles, Calif.—A water bond issue of $3,000,000 at 5 per cent brought no bids Feb. 3.

San Diego, Calif.—City redoubling efforts to sell $2,695,000 bonds for constructing of El Capitan dam. Some $900,000 available; propose to continue dam site exploration and clearing.

What of city administration?

The unfortunate position in which these cities find themselves today is intimately connected with the deflated condition of the country's business enterprise. Payment of taxes comes hard to many city people because of their reduced income. But at the same time those taxes represent payments for services they have demanded in the past and still demand. The conveniences of city life, it should be unnecessary to say, are not created free of charge.

As the present attack on budgets is largely directed at public improvements, at the technical services generally rather than the older law-and-order functions of government, a conscientious re-appraisal of municipal engineering is called for. Is the scope of municipal public-works improvements excessive? Is their planning, execution and operation efficient? How can the costs be reduced without impairing their civic value?

These questions comprise the theme of a series of articles, of which this is the first, to appear in *Engineering News-Record* from time to time during the coming months. The next article to appear will deal with the increase during recent years in the scope and cost of municipal services and the reasons why that increase has come about.

Municipal Loans Aided by Credit Relief Laws

Municipal credit stringency should be relieved by a number of moves started in Washington to make credit more free, but their success depends upon the banks and upon hoarders

By D. B. Woodward
Financial Editor, The Business Week, New York

MUNICIPALITIES and other governmental units, in the past few months faced with an extreme shortage of money, may find the money situation distinctly eased up in the early future, through the effect of government action. The essential facts of the new developments are here outlined.

Since last fall, and particularly in recent weeks, bonds have been unsalable in many cases, very difficult to sell in many more, and the banks have been unwilling to make short-term loans. The causes are (1) general credit restriction on a national scale, and bankers' disapproval of the financial status of governmental bodies, in some specific cases. The result has been such a shortage of funds that many cities and other units have been forced to reduce or stop construction, to discharge employees and to cut expenditures in every direction. Many of the specific sources of trouble have been in part corrected by budgeting changes.

Now the federal government is attempting to relieve the national credit shortage. There are three separate elements in these attempts:

The first move was establishment of the Reconstruction Finance Corp., for which President Hoover signed the bill passed by Congress on Jan. 22. The corporation is given $500,000,000 from the treasury and is authorized to borrow 1,500 millions more if necessary, all of which is to be used to relieve credit stringency. First loans have just been made.

As the second move, a national campaign against hoarding—hoarding being one cause of the shortage of money—was announced by the President on Feb. 4. It is headed by Col. Frank Knox of Chicago.

Finally, the extreme need for credit relief brought the Glass-Steagall bill, announced Feb. 11, to throw the weight of the federal reserve system into the credit-expansion effort. This bill has been passed by the House, and at this writing is being debated in the Senate. It is certain to pass, probably early next week.

Effect on municipal finance

Municipal and other governmental financing should be aided by these financial forces that Washington has assembled in its attempts to stimulate business. They are designed to work through the banks, except that the Reconstruction Corp. can lend directly to the railroads, to agriculture and on exports.

Since these forces operate through the banks, technically the situation faced by the municipalities and other governmental units that desire and need to borrow is not changed. They still must get their short-term funds from the banks and other lending institutions, and their long-term funds from the securities markets via the houses of issue. The federal reserve banks still have authority to buy municipal t warrants with fifteen days' maturity a the privilege of renewal. But the re serve banks have never been willing t buy any appreciable amount of thes and there are no indications that the policy is changed or will change. O Dec. 31, 1931, they held only 4.4 mi lions worth, and even that small tot is a bit larger than usual.

But while the situation is not change technically, actually it is changed i marked degree. This applies to bot short-term and long-term financing.

Applications for short-term loans no find the banks in a very changed posi tion from a few weeks ago. They ar now able to follow a much more liberal lending policy, assuming always that the quality of the applications is such as to assure reasonably safe loans.

Loans and bonds freer

The banks are now backed by the resources both of the Reconstruction Corp. and of the federal reserve system, to either of which they can now turn for cash in time of need. With such powerful backing they need not carry such a high proportion of immediately liquid reserves. They now can get cash from the Reconstruction Corp. *on any of their assets* excepting foreign obligations but *including municipal obligations.* Under the terms of the Glass-Steagall measure member banks of the federal reserve system can take any securities, including municipals, to the reserve banks and obtain cash in case of need. The very largest banks may be excluded from this privilege, but this point has not been decided by Congress at this writing.

Essentially the same consideration applies to long-term funds—municipal bonds. With this backing the banks can now increase their investments, since they are no longer obliged to carry so much cash and its equivalent. If they take advantage of this possibility, the municipal bond situation will be appreciably improved.

All that has been said of banks applies in almost equal force to other types of financial institutions, such as the life-insurance companies and the savings banks. While these institutions can not obtain relief from the reserve banks, the Reconstruction Finance Corp. is permitted to advance funds to them on their assets.

On the other side, every effort is being made to stop the threat of deposit withdrawals from the banks for hoarding. This effort includes the anti-hoarding campaign and the attempts to restore confidence in the banks through all of the moves that are being taken.

The actual extent to which the stringency of municipal and other governmental credit is relieved therefore rests primarily with the banks. Secondarily, it depends on the extent to which the confidence of depositors is re-established in their banks.

The Radial-Cone-Bottom Tank for Elevated Water Storage

Fundamental feature is provision of large capacity in shallow depth as exemplified by 1.5-m.g. Indianapolis tank—Latest and largest of type at Columbus, Ohio, also utilizes part of roof volume for water storage

A RADICAL INNOVATION in elevated-tank design, first suggested about 1929, involves the use of a comparatively flat-bottom tank made up of a series of troughs radiating outward from the riser pipe to the tank shell. This design replaces the usual suspended hemispherical and ellipsoidal bottoms, and has now been incorporated in five tanks varying in capacity from 1¼ to 2 million gallons each. The largest of these tanks, recently completed by the city of Columbus, Ohio, includes the additional feature of a domed roof carried by outside roof trusses and designed to permit water storage. In this article the radial-cone-bottom design is presented in some detail, since only brief comment has appeared in print previously. Specific mention is made of the Columbus installation.

The basic advantage of the radial-cone-bottom design is that it may be utilized to provide large elevated storage capacity in a comparatively shallow tank. Thus, the variation in head on pumps or pipe mains, as measured between a full and an empty tank, is reduced to a minimum. In the first tank, built for the New York Water Service Corp. in Brooklyn in 1930, storage of 1,250,000 gal. of water was accomplished in a vertical height of 27 ft. In the 1,500,000-gal. Irvington tank put in service last year by the Indianapolis Water Co. the total variation in head is 25 ft. This tank, which is 104 ft. in diameter, presents in fact a better example of the radial-cone-bottom principle than the 86-ft.-diameter Columbus tank in which, a small range in head not being imperative, a 2,000,000-gal. capacity is provided in a depth of 50 ft. In addition to the above-mentioned tanks, the radial-cone-bottom principle has been incorporated in a 1,000,000-gal. tank at Sandusky, Ohio, which is completed, and in a 1,500,000-gal. tank under construction for the city of Evanston, Ill.

Economics of elevated water storage

The radial-cone-bottom tank was first discussed publicly by the originator, George T. Horton, president of the Chicago Bridge & Iron Works, at the 1929 A.W.W.A. meeting at Toronto. In his address Mr. Horton pointed out how the demands for increased capacities and small head variation in elevated-storage tanks had revealed inherent difficulties in the usual suspended-bottom design. For example, if a 1,000,000-gal. hemispherical bottom tank is limited in height to 40 ft., the resulting tank will be all bottom, since 1,000,000 gal. is the capacity of a hemisphere 80 ft. in diameter; bottom plates being costly to fabricate, such a tank would not be economical. Using an ellipsoidal bottom, which has a vertical height one-half that of a hemisphere of the same diameter, obviates some of this difficulty but introduces another disadvantage in that compressive stresses are present in such a bottom and become sufficiently high in tanks of large diameter to necessitate an increase in

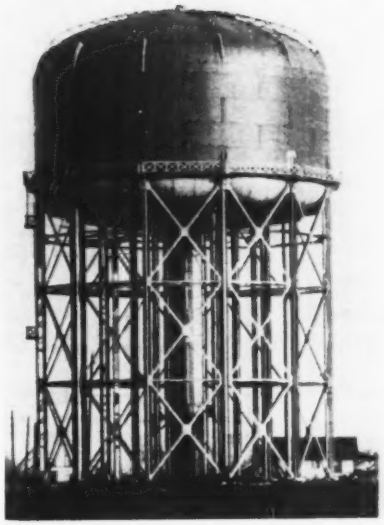
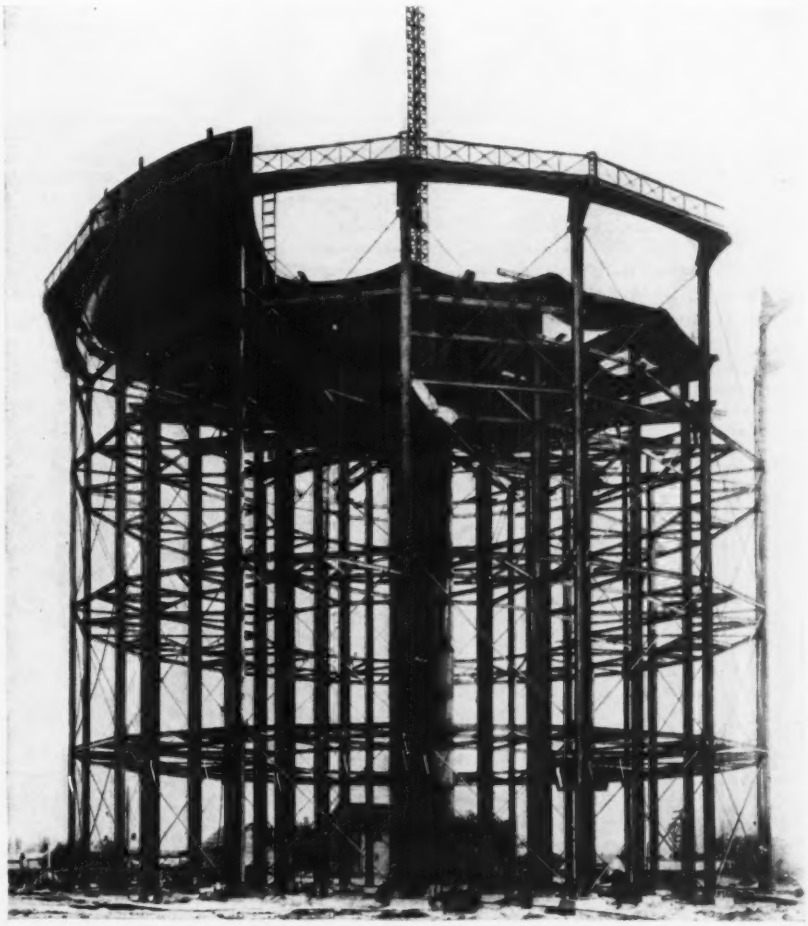


Fig. 1—Outside roof trusses lend new architectural note to 2,000,000-gal. elevated water tank in Columbus, featuring water storage in roof and comprising the largest radial-cone-bottom design yet built.

Fig. 2—Erecting the 1,500,000-gal. radial-cone-bottom tank at Indianapolis. Note plank staging that supports bottom plates during assembly and riveting.



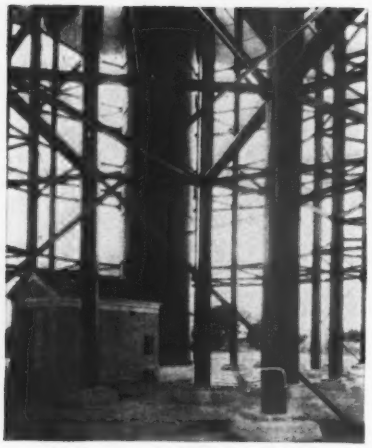


Fig. 3—Radial-cone-bottom tanks require extensive system of column supports. View shows base of Indianapolis tank.

the depth of the bottom, thus increasing the head variation, which is contrary to the result sought. Mr. Horton stated that, while the suspended bottom tank is the most economical form for all ordinary sizes and for conditions where the height of the tank is not limited, it is not the most economical for large capacities that must be confined within a narrow vertical height; if this height is 25 ft., the maximum practical capacity for a hemispherical-bottom tank is 175,000 gal. and for an ellipsoidal-bottom tank 300,000 gal. In increasing the size of a suspended-bottom tank with a limited height a point is reached, according to Mr. Horton, at which the additional material required in the bottom to resist the increased stresses will more than offset the cost of girders and columns necessary to support a flat bottom.

Radial-cone-bottom design

As a result of this reasoning, the radial-cone-bottom tank was developed. This bottom consists of a number of radial troughs, each trough being part of the surface of a cone having its apex at the center of the tank. Each trough would theoretically intersect and connect to its two adjacent troughs along two radial lines; actually a connection is made through a bent or welded plate hung over a radial supporting girder. Each of these radial girders is in turn supported by the central riser pipe and by a number of steel columns.

The radial-cone bottom offers some advantages in flexibility and certainty of design. For instance, since the stress in a bottom plate is directly proportional to its radius of curvature, the stress in a radial-cone bottom may be reduced as much as desired by decreasing the radius of the troughs, either by utilizing a greater depth of trough or by increasing the number of troughs. In a suspended-bottom tank the amount of tank load carried by the riser pipe is an indefinite quantity; in the case of a radial-cone bottom the riser carries a load as definite as that carried by any of the columns, although care is necessary in allocating load to columns and riser. In general, the radial girders are designed as continuous over two or more supports, and a reasonable assumption is made as to the rigidity of the girder-to-riser connection. As a matter of detail, the columns supporting the girders for all radial-cone bottoms thus far built have been so spaced as to bring equal loads on all columns.

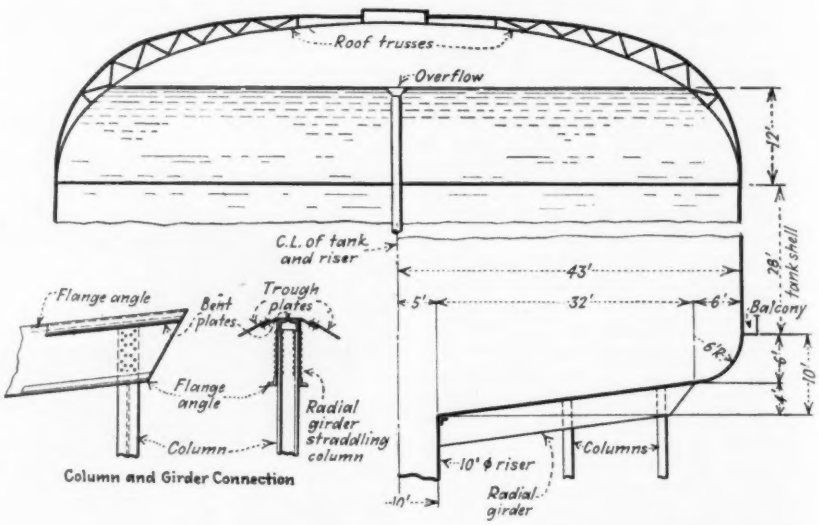
On the first radial-cone-bottom tank erected in Brooklyn the radial girders and troughs extended from the riser pipe to the cylindrical tank shell. Chiefly to improve the appearance of the structure, on subsequent installations the girders and troughs were stopped off some distance from the shell and connected there to an annular ring of shaped plates that curved outward and upward into the shell. This arrangement is shown in Fig. 2 for the Indianapolis tank and in Fig. 4 for the Columbus tank. It will be noted that for the latter the radial vertical section through this annular ring is the quadrant of a circle of 6-ft. radius.

This change in design introduced the necessity for another assumption to distribute the load beyond the end of the radial trough. The designers point out that a tangent to the annular ring of plates at the connection to a radial girder is horizontal, so that it may be assumed that all water outside of an imaginary vertical cylinder through the ends of the radial girders is carried to the shell of the tank, then to the columns connected directly to the shell. This assumption, it is stated, has been verified by actual column-load measurements.

Details of Columbus tank

The Columbus tank is the largest radial-cone-bottom tank yet built. In so far as the bottom is concerned it follows strictly the radial-cone design practice described above. Its distinguishing feature, other than large capacity, is the utilization of part of the roof volume as tank capacity. In previous tanks the upper capacity line is at the top of the cylindrical shell, but at Columbus the high-water line is 12 ft. above the top of the shell, or well into the roof. The roof plates above the overflow line are of ordinary thickness material, but those throughout the water-carrying portion are necessarily heavier. Another consequence of the utilization of roof volume as tank capacity is the necessity for outside roof trusses, which add a distinguishing characteristic to the tank. The actual shape of the roof was decided largely on the basis of appearance, an ellipsoidal form being used with a total roof rise of 21½ ft., or one-fourth of the tank's diameter. In the Columbus tank the bottom, considered to be 10 ft. deep (Fig. 4), has a capacity of 330,000 gal.; the cylindrical portion of the shell,

Fig. 4—Details of 2-m.g. radial-cone-bottom tank at Columbus Ohio, showing roof water storage and outside roof trusses.



In the Columbus tank twelve radial conical troughs are used, connected to twelve radial girders, each 32 ft. long and supported by the riser and two H-section columns. The radial girders are of double-web type (Fig. 4) and straddle the columns. In addition to the two circles of twelve columns supporting the girders, there is an outer circle of twelve columns connected directly to the cylindrical tank shell. The riser pipe is 10 ft. in diameter. The bottom of the tank is 75 ft. above the top of the foundation piers.

28-ft. high and 86 ft. in diameter, contains 1,206,000 gal.; and 470,000 gal. may be stored in the roof, making the total tank capacity slightly in excess of the nominal 2,000,000 gal.

Electrical Devices Control Level in New 1.5-m.g. Tank

Hydraulic altitude valve actuated by solenoid and remote recording of tank level by electrical transmission feature new radial-cone-bottom elevated-tank installation in Indianapolis

By Homer Rupard
Principal Assistant Engineer, Indianapolis Water Co., Indianapolis, Ind.

ELECTRICALLY ACTUATED devices control the operation of the recently constructed Irvington elevated storage tank of the Indianapolis Water Co. and provide a continuous record at a remote point of the water level. A hydraulic valve connecting the tank and the distribution system is closed when the tank is full and is opened again when the line pressure has dropped a definite amount. The remote-recording water-level indicator transmits its reading over 11 miles of telephone line to a chart in the pumping station serving the district.

The tank has a capacity of 1,500,000-gal. and is of the radial-cone-bottom type, 97½ ft. to the top, with a 25-ft. depth of water storage. The tank is located at the extreme eastern edge of the city and is connected to the Irvington high-pressure district, serving a population of 50,000. The capacity and height of the tank were designed so that the tank could float on the system at all times. The radial-cone-bottom tank is a relatively new development in the field of elevated water storage, its chief function being to provide large volumes of storage within a minimum range of head. Pertinent facts concerning its design are given in the preceding article, in which some of the illustrations show views of the Indianapolis tank.

Instrument and control equipment for the Indianapolis tank are housed in a structure at the base of the riser pipe. The 24-in. supply pipe for the tank passes through the basement, where the altitude valve is located. Instrument and control equipment, arranged along the two side walls of the superstructure of the building, consist of three major items: the altitude-valve control, the tank-level transmitter and the automatic heating equipment.

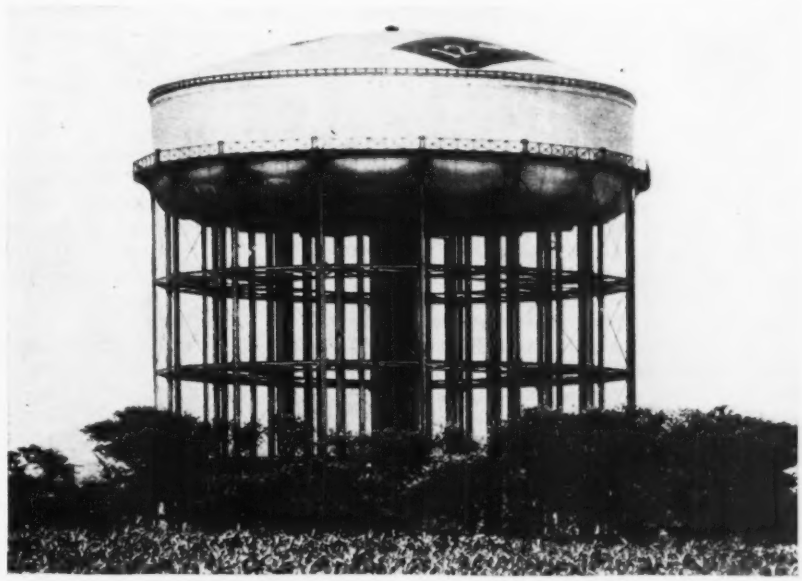
Altitude Valve—The hydraulic altitude valve is controlled by a four-way value operated by a solenoid. A mercoid pressure switch connected to the street side of the altitude valve opens the electric circuit to the solenoid when the tank fills, de-energizing the solenoid and closing the valve.

The switch is set so that it will not reclose the circuit to open the valve until the pressure on the street side drops to about 7 lb. below full-tank pressure. To eliminate surges in the distribution system, the discharge from the hydraulic cylinder is throttled so that a period of 3 minutes is required for the valve to open or to close.

While the normal operation of the tank is for it to float on the distribution system, a time clock and the necessary wiring and equipment are provided on the valve control panel so that the tank may be shut off at any desired time and held off until the peak-load period of the day.

Tank-Level Transmitter—The tank-level transmitter is of the current-balance type and uses radio tubes instead of a reversible motor-driven rheostat to maintain a line current equivalent to the indication being transmitted. The current-balance type of transmitter was selected because it ap-

Fig. 2—New 1.5-m.g. radial-cone-bottom tank at Indianapolis.



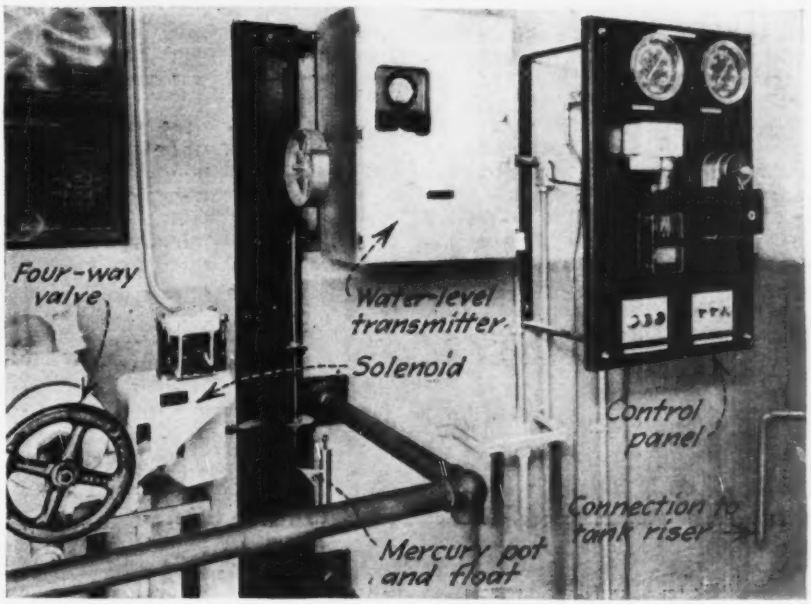


Fig. 1—Instruments and control equipment are mounted on the wall of the control house adjacent to the tank riser.

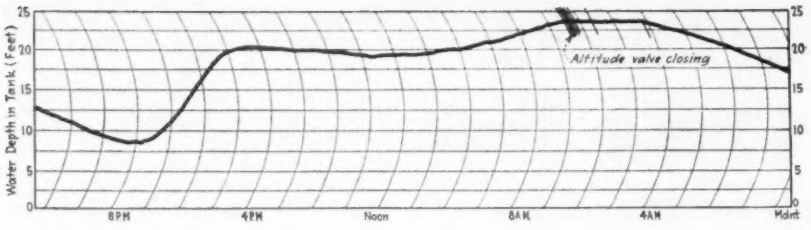


Fig. 3—Typical water-level chart drawn by the remote recorder.

peared to be the only type of equipment available that would automatically compensate for changes in line resistance and voltage.

A graphic record of the tank level is made at the Fall Creek Pumping Station, 11 miles pole-line distance from the tank, the record being transmitted over a pair of wires of 2,000 ohms resistance leased from the telephone company. Electric current is supplied to the transmitter at the sending end and is subject to some fluctuation in voltage.

A special mercury column and float was designed to transmit the water-level changes to the instrument. The receiving recorder for the level transmitter is a standard strip-chart recording milliammeter, calibrated in feet of water. Fifty milliammeters is the full-scale value equivalent to 25 ft. of water in the tank. A glass plate with a rate diagram ruled upon it is placed in front of the strip chart so that the station operator may determine the filling or emptying rate of the tank by observing which rate line the chart record line is paralleling. This information enables him to regulate the pumping rate.

A separate contact-making receiving instrument is installed to light warning lamps at the full and empty points of the tank.

A signal to show when the altitude valve opens and closes has been superimposed on the level transmitter. The mercoid pressure switch has two tubes, one of which controls the altitude valve solenoid circuit, while the other is connected so that it will cut in an additional resistance of some 400 ohms in the telephone circuit when the switch throws to the closed position. The cutting in of this additional resistance causes the transmitted current to drop sharply about five milliamperes, and then recover immediately as the current-balance feature of the transmitter adjusts the transmitted current to the proper value. This action gives a dip of the pen on the chart. When the altitude valve opens, the mercoid switch cuts out this extra resistance, and the recorder pen swings upward an equal amount. This signal feature has proved to be very useful in the operation of the tank.

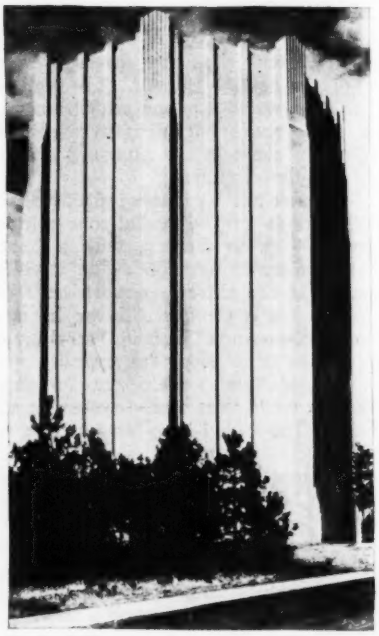
Heating Equipment — The heating equipment for the structure consists of six 500-watt electric space heaters, mounted in pairs, and controlled by thermostats set to maintain a temperature between 35 and 45 deg. F. The structure was carefully designed and built to minimize heat losses.

This equipment has been in service since July 27 and has functioned satisfactorily. The Automatic Cone Valve Co. furnished the altitude valve, and the Esterline-Angus Co. the level transmitter. The tank was furnished and erected by the Chicago Bridge & Iron Works. Grading and foundations were done by Ray Fatout, Inc., local contractors. The design of the control apparatus was made and the installation supervised by the writer under the direction of W. C. Mabee, chief engineer. H. S. Morse is general manager of the Indianapolis Water Co.

Monumental Water Tower Designed Against Earthquakes

By Alex Lindsay
Superintendent, Water Department, Spokane, Wash.

A LARGE water tower of monumental appearance recently constructed in one of the higher-class residential districts of Spokane, Wash., consists of a 1,250,000-gal. flat-bottom steel tank, 78 ft. in diameter and 35 ft. high, incased in the upper part of an outer shell of concrete rising 122 ft. 8 in. above the ground surface. The supporting structure for the tank is made up of a series of rectangular cells 12 ft. square, on top of which (84½ ft. above the ground) is a 16-in. reinforced-concrete slab that acts as a foundation for the steel tank. At the intersection of the walls forming the rectangular cells the forms were so arranged as to make a 23-in.-diameter column. The walls of the cells are solid from the ground level to the under side of the top slab, except for intercommunicating openings at the bottom and for ventilating openings just below the top. This cellular construction is very rigid, insuring the safety of the structure against seismic disturbances.



A 1,250,000-gal. steel tank is hidden inside of this concrete inclosure.

The steel tank was, after erection, treated on the interior with a hot coat of enamel, while graphite paint was applied to the exterior. The outside of the bottom was given a heavy coat of plastic material before it was lowered onto a bed of coal tar and sand on the supporting concrete floor.

Vertical lines are emphasized on the exterior of the tank to accentuate the appearance of height. The outside wall, as well as the columns and curtain walls, were constructed with slip forms that contributed greatly to the rapid completion of the work and to the economy of the job. The placing of 2,525 cu.yd. of concrete in the inner and outer walls of the tank required only fifteen days.

The contract price for the tower was $81,283. About 6,000 bbl. of Spokane-made cement was used on the job, and 140 men were given employment. Moderately severe winters and the alternate freezing and thawing to which the tower will be subjected made it necessary to give special attention to the mixing, placing and curing of the concrete in order to insure durability. A 1:2:3 mix was used.

Andrew J. Fabian is commissioner of public utilities of Spokane. The tower was designed under the direction of the writer, while the detailing of the plans was done by J. W. Robinson, engineer for the water department. The architectural treatment was rendered by Whitehouse & Price, and E. Blum, Spokane, superintended the construction for Morrison & Knudsen, contractors.

Incinerator Fired by Digester Gas Burns Screenings and Grease

Noisome wastes at Aurora, Ill., sewage plant, formerly buried, now disposed of without odors

UTILIZING the gas from sludge digestors, the Aurora, Ill., sewage-treatment plant burns its noisome screenings, tank grease and scum in a small incinerator. Odors drifting out of the mouth of the main intercepter are also put through the incinerator. The installation was described Jan. 28 by Walter A. Sperry, superintendent, Aurora Sanitary District, before the Illinois Society of Engineers at the Peoria meeting. Notes from Mr. Sperry's paper follow:

The incinerator was set up in the screen house adjacent to the fine screen and to the separator box receiving the grease and scum from the tanks by pumping. It contains 8 sq.ft. of grate surface and is lined throughout with 9 in. of firebrick. The overall dimensions of the incinerator proper are 9 ft. 8 in. long, 4 ft. 11½ in. wide and 7 ft. high. A forced-draft fan assists the stack, built only 21 ft. high to avoid marring the exterior appearance of the screen house. This fan draws its air supply from a steel-plate receiving and storage bin on top of the furnace, and discharges its air through a steel jacket built around the smoke breeching, which results in considerable preheating before it is delivered beneath the incinerator grates.

The gas is fed through two box burners set below the front stoking door and arranged so as to get direct impingement of the gas on the burning material.

One of the distinctive features of this incinerator is the use of the receiving and storage bin, which rests on the rear end of the incinerator. It is equipped with a false bottom made of perforated plates and a drain line. The incinerator feed opening, 12 in. in diameter, is located in the cabinet floor near the back, and it discharges onto the back or inclined portion of the burning grates below. It is closed with a conical firebrick-faced plug controlled by a counterweight. Double doors located in the rear give adequate and convenient access. This cabinet stores and conceals from view the unsightly material from the screen house and tanks as it accumulates. Opportunity is given to drain and dry. This bin is the source of air supply for the draft fan, which maintains a negative air pressure preventing any odor arising from the stored material. Advantage was taken of this arrangement to control odors drifting out of the mouth of the main interceptor by closing the opening with a suitable gate and venting the accumulating gases through a 6-in. tile tapped into the top of the interceptor back of the gate and extended to a connection to the bin.

Acceptance Test—During an acceptance test 10 cu.ft. of material, weighing 648.7 lb., was consumed in four hours. The volume of gas consumed (650 B.t.u. per cubic foot) was 1,150 cu.ft. Screenings made up 5.1 cu.ft., or 334 lb., of the material burned and 315 lb. of grease and scum composed the remainder. The major charge of screenings, 4¼ cu.ft., averaged 80.6 per cent moisture, 30.5 per cent ash (dry basis) and 940 B.t.u. per pound as fired. The first and major charge, 4¼ cu.ft., of grease and scum averaged 73.2 per cent moisture, 6.2 per cent ash (dry basis) and 3,442 B.t.u. per pound.

The combustion chamber temperature rose from 1,380 deg. F. at the start to 1,460 deg. at the close, with a maximum of 1,460 deg. and a minimum of 1,260 deg. and an average of 1,362 deg., as against 1,050 deg. as the minimum temperature required to destroy odor.

The temperature of the air supplied by the draft fan at the wind box after preheating shifted from 284 deg. at the start to 276 deg. at the close of the test. It reached a maximum of 300 deg., a minimum of 264 deg. and averaged 274 deg. F. This was about 100 deg. higher than the designer thought might be maintained through the use of the air preheater around the stack breeching. The stack was entirely free from both smoke and odor throughout the test. The total capacity was 25 per cent above the guaranteed capacity of 8 cu.ft. On the B.t.u. basis per cubic foot the incinerator did its work on but 52.7 per cent of the fuel allowed by the terms of the contract.

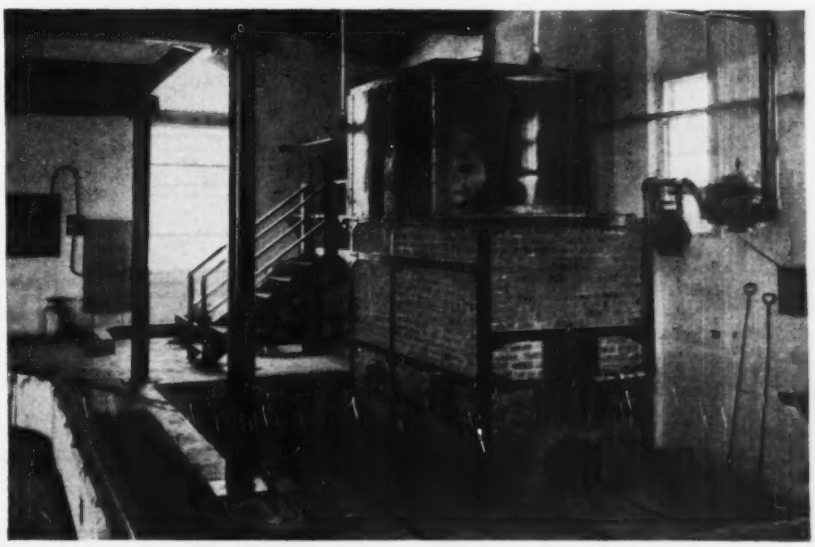
Since its installation, Mr. Sperry stated, several experiences have indicated justification of the worth of the incinerator economically as well as psychologically. The cost of burial has been eliminated. This required time to dump the cars and the occasional hiring of teams to prepare burial trenches. Last fall the dump required some general attention. A team was used for three days for leveling purposes as well as for spreading. This resulted in stirring up the old screenings, revealing the fact that they were as fresh and malodorous as the original material.

Some weeks after the incinerator was installed the screen openings were reduced from 1¼ to ½ in., as originally installed. The volume of screenings were thereby increased from 4 to 8 cu.ft. per day, which resulted in much cleaner tank surfaces and improved grease-pumping conditions.

Odor complaints about the grounds have been greatly reduced due to the use of this furnace to consume all surplus digester gas during the summer season when a lesser volume is required for digesters and building heat. The gas averages 460 p.p.m. of hydrogen sulphide.

Accidental or criminally intentional dumps of oil and grease, not possible to trace, occur periodically. Against this operating bugbear the incinerator is a permanent means of disposal.

The incinerator cost $2,700 and was specially designed for this job by E. L. Brown, chief engineer, Mid-West Incinerator Corp., Chicago, the contractor.



Incinerator at Aurora sewage plant burns screenings and grease. Feed is through cabinet on top of furnace, in which negative pressure is maintained by the draft fan supplying the air of combustion.

Where the Money for Rural Roads Comes From

Analysis based on official records shows that road users and motor vehicles, not general taxation, are building principal American highways

By R. C. Fulbright

Fulbright, Crooker & Freeman, Attorneys at Law, Washington, D. C.

DEVELOPING under various designations the doctrine that highway financing by the federal and state governments constitutes virtually a subsidy to highway transportation, propagandists for the railways have been more pressing during the last year than they have ever previously been in demanding either that they be relieved of charges for government or that the users of the highways be subjected by government to heavier charges. Concurrently the bus and truck transportation interests have been equally active in condemning present taxes and traffic restrictions as excessive and confiscatory. The situation is natural in an adjustment period when new channels of transportation are being developed and traffic is groping to find out the division between the new and the older ways that is most profitable for it. Its greatest evil lies in the flood of misstatement and perversion of facts relating to the sources and kinds of current roadbuilding funds. To make the facts clear, a precise analysis is presented in the following article. Whatever the future conclusion may be of the justice and economics of traffic division, taxation and regulation, it should not be developed from misapprehension of the sources and kinds of the funds that are paying for highway improvement.—EDITOR.

THE SUBJECT of the origin and character of the funds expended in highway improvement is best introduced abruptly by two charts showing, according to figures carefully compiled by the United States Bureau of Public Roads, the funds raised annually by taxation for original expenditure by state and local highway officials. It will first be observed that federal aid is extended only for the construction of state highways.

Explanation of income graph

That portion of the charts described as taxes is primarily composed of general property taxes levied in the several states. There are some special taxes, such as assessments against abutting property, although the policy of taxing abutting property for rural highways always has been negligible and now is not followed as a state highway policy in any state. There are some other special taxes, such as levies in counties for bond interest and sinking funds for local roads.

The band described as appropriations also includes some special taxes to pay bond interest and retirements and also appropriations from revolving funds for such purposes. Under the heading of miscellaneous there are included special taxes in some states for inspection and special services, also inheritance taxes (where any part thereof is available for such expenditures), and refunds or salvage on equipment disposed of.

Sources of income have changed

It will be observed that in seven years gasoline taxes and motor vehicle fees have come to be the principal source of funds for expenditure by state highway officials. Correspondingly, gasoline taxes and motor-vehicle fees have come to furnish an important part of the funds for the local country roads, whereas in 1923 they comprised a very small part. Table I shows some of the figures, for the years 1923-1930 inclusive, upon which the graph has been constructed. Taking the ratio for 1923 and that for 1930 of the amount of funds derived from each of the respective sources, to the total amount raised for each year, we arrive at the statement of percentage ratios shown by Table II.

In the case of state highways it will be noted that in 1923 only 7.79 per cent of the income was derived from general taxation, and that this had fallen in 1930 to the negligible proportion of 1.31 per cent. Also it will be noted that, even in 1923, 52.13 per cent of the total receipts for state highways were direct from motor-vehicle users, and that in 1930 this percentage had increased to 82.09 per cent.

In the case of the local roads, in 1923, only 8.86 per cent of the receipts came direct from motor-vehicle users, where in 1930 this proportion had increased to 23.48 per cent. On the other hand, the proportion of receipts derived from general taxes for support of local roads had decreased from 64.33 per cent in 19[illegible] to 57.75 per cent in 1930.

Motor-vehicle taxes mount

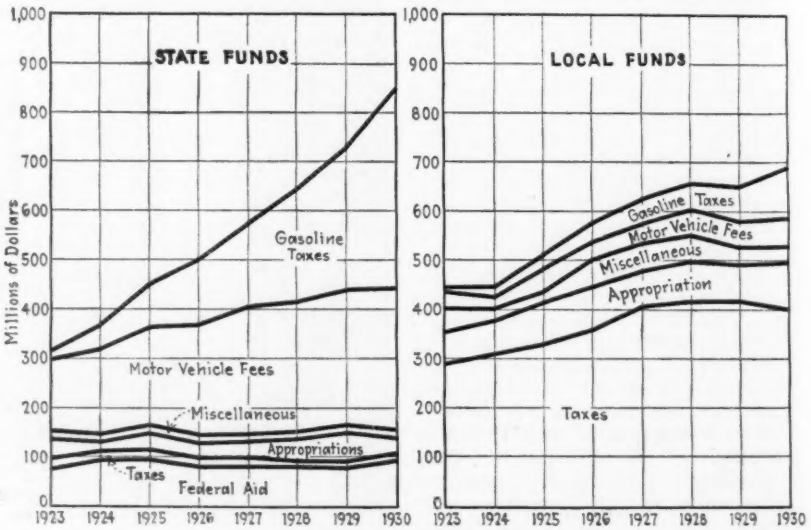
The trend of increase in charges upon the motor vehicle is notable. The total revenue from gasoline taxes for state highways was some 26 times as great in 1930 as in 1923, and for local roads it was slightly more than 26 times as great in 1930 as in 1923. The revenue from motor-vehicle fees for state highways had approximately doubled in the seven-year period, while the receipts from such fees for expenditure by local officials had increased more than 53 per cent. Receipts by state highway officials from appropriations had actually declined during the seven-year period, while those for local highways had increased only 33 per cent. It is significant that in 1930 the receipts from gasoline taxes and motor-vehicle fees for expenditure on state highways were more than $700,000,000, as contrasted with $11,000,000 from general taxes.

Property not taxed for main roads

The obvious conclusion is that the general property taxpayers are not supporting that class of highways carrying traffic that primarily competes with the railroads, and therefore the deductions made by certain railway protagonists can only be justified by assuming that the local county roads are equally competitive avenues with the railroads. It is a matter of common knowledge that there is no substantial basis for such an assumption.

Reference has been made to the fact that federal aid is only extended for assistance in constructing state highways.

Annual tax revenues for original expenditure by state and local highway officials.



It will be noted that, in 1923, 23.1 per cent of the funds received for expenditure on state highways came from federal aid, whereas in 1930 only 10.83 per cent was derived from this source. However, as shown by the detailed figures in Table I the amount of federal aid rendered varied in round figures from $72,000,000 in 1923 to $92,000,000 in the years 1925 and 1930.

The governmental policy of encouraging the development of a national highway transportation system was adopted in 1916, and the first appropriations therefore were made in the fiscal year 1917. Since 1917 the government has collected $1,127,797,760 in excise taxes directly levied on motor vehicles and on parts and accessories. From the beginning of federal aid in state highway development to and including the fiscal year 1930 the federal government had disbursed $819,452,024 in aid of state highway construction, or but 72.7 per cent of the amount received by it as special taxes from the motor-vehicle industry. While the receipts from these excise taxes have not been earmarked by the federal government for expenditure upon roads, nevertheless it is obvious that the industry has directly contributed in special taxes substantially more than the federal government has expended in aid of the highway transportation system. In addition to this, the automotive industry as well as the operators and owners of automobiles have paid other federal taxes in like manner, as has been required of citizens generally.

Life of highways

With reference to the theory that, to keep the life of the bonds within the life of the investment, "one-tenth of outstanding bonds should be paid or retired each year," any assumption that highways of the character constructed with bond funds have a life of only ten years is not supported by present-day highway engineering authority. On the contrary, the Bureau of Public Roads has made certain analyses and studies of the mileage of state highways that have received federal aid. There were about 70,000 miles of such highways aided up to the close of 1928 that were involved in such study. A substantial part of the cost of these roads was for objects other than the construction of surfaces, such as roadbed and drainage structures that have a relatively long life. For example, 70 per cent of the cost of construction of sand-clay roads went into such relatively permanent works as grading, drainage structures, bridges and culverts, all of which are considered as having an ordinary life that can be safely estimated as exceeding 50 years. In the case of the gravel roads, grading, drainage structures and bridges constituted 49 per cent of the total cost.

In the total aggregate of roads of all types, it was estimated that not less than 40 per cent of the total cost went into grading, drainage structures, bridges and culverts.

Moreover, in the case of surfaced roads, there are numerous hard-surfaced roads that have been carrying heavy traffic for twenty years, and therefore it cannot yet be estimated just what the life of a paved road is. The life of the surface of ordinary gravel and sand-clay roads will depend largely upon the character of maintenance, but even when the surface wears out there is a substantial part of the value thereof that may be incorporated into the base for a new superstructure.

In view of these findings, the mere wearing out of the surface is no proper criterion by which to determine the life of the road as a whole, when the surface constitutes only one of the elements of its construction.

There has been tremendous progress in highway engineering within the past ten years, and it may safely be said that the average type of state highways being constructed today should have a substantially longer life than those that were constructed in the early days when the development of the automotive traffic was still in an experimental state and many of the highway problems were then unknown.

Life of highway bonds

The Bureau of Public Roads has recently made an analysis of all state highway bonds outstanding as of the close of 1930, involving a total of $1,151,572,000. The weighted average term of all such bonds when issued was 19.79 years, and there was only one state where the average term of the outstanding highway bonds exceeded 25 years. This exception was New York State, where the average was slightly in excess of 40 years.

Since New York is the only state that shows an average term for outstanding bonds in excess of 25 years, it may be well to cite the experience of that state. The first bonds for highway purposes in New York State were issued in the sum of $1,000,000 in 1906. The first substantial issue was in 1908, when $10,000,000 were issued. At that time the state adopted the policy of issuing 50-year sinking-fund bonds, and it was the policy of the highway department to use state bonds in building highways of permanent character. From 1906 up to 1917 there was a total of $80,000,000 of 50-year bonds issued, the average weighted date of issue being about 1913. There was a substantial amount of criticism of the policy of issuing such long-term obligations for road purposes and, as a consequence, no 50-year-term bonds have been issued since 1917.

In 1921 the state issued $20,000,000 of serial bonds maturing in series running from one to fifty years, and therefore having an average maturity of 25½ years. Since that time it has been the policy of the state to issue serial bonds of this character, and, in fact, the only state bonds issued for highway purposes since 1921 appear to be bonds issued for construction of highway structures over or under railways. Manifestly such structures are practically of permanent type.

While all of the 50-year bonds are still outstanding, it is worthy of comment that since the issuance of these bonds up to Dec. 31, 1930, the state had built up a sinking fund of $38,432,744.95, or almost enough to retire one-half of the bonds, although the average term expired was only about one-third of the total bond life.

Estimates made by state representatives are that the life of the highways constructed with the bond issues may be conservatively estimated at twenty years. It will therefore be seen that even in New York the present policy is to issue bonds with an average maturity within what is estimated to be the life of the highways. The fact that the weighted average bond period for all states is less than twenty years, and that the experience of highway engineers would place the weighted average life of the various structures entering into highways at not less than twenty years, would have the

TABLE I—FUNDS RAISED ANNUALLY BY TAXATION FOR ORIGINAL EXPENDITURE BY STATE AND LOCAL HIGHWAY OFFICIALS

(Funds received by transfer from local to state authorities, and vice versa are not shown, since such funds are not original receipts. The figures represent correctly all funds raised by taxation.)

	Funds for Original Expenditure by State Highway Officials			
	1923	1925	1927	1930
Gasoline taxes	$15,872,884	$89,328,340	$176,769,657	$411,109,446
Motor-vehicle fees	147,075,966	199,845,163	239,955,128	289,801,738
Miscellaneous	15,498,492	15,051,966	12,521,969	17,083,821
Appropriations	37,461,579	33,390,642	30,794,645	32,136,298
Taxes	24,348,478	21,489,004	18,769,561	11,181,693
Federal aid	72,343,401	92,180,406	80,159,671	92,462,836
Total	$312,600,800	$451,285,521	$558,970,631	$853,775,832

	Funds for Original Expenditure by Local Officials			
	1923	1925	1927	1930
Gasoline Taxes	$4,137,401	$24,833,979	$46,860,508	$107,110,709
Motor-vehicle fees	35,717,942	46,545,445	40,239,856	54,911,122
Miscellaneous	48,284,360	23,966,034	56,535,744	33,338,076
Appropriations	72,332,907	82,564,411	72,692,737	96,195,337
Taxes	289,331,628	330,260,816	405,219,774	398,437,988
Total	$449,804,238	$508,170,685	$621,548,619	$689,993,232

TABLE II—RATIO OF AMOUNT RAISED BY EACH TYPE OF TAXATION TO THE WHOLE

	1923		1930	
	State	Local	State	Local
Gasoline taxes	5.08	0.92	48.15	15.52
Motor-vehicle fees	47.05	7.94	33.94	7.96
Miscellaneous	4.96	10.73	2.00	4.83
Appropriations	11.98	16.08	3.77	13.94
Taxes	7.79	64.33	1.31	57.75
Federal aid	23.14	.....	10.83	.....
Totals	100.00	100.00	100.00	100.00

effect of entirely wiping out the frequently stated figures of "accumulating deficits." In fact, if the average life of the highways is 25 years, there would be an accumulating value rather than an accumulating deficit.

It is true that the foregoing analysis deals only with state highway bonds. In addition thereto, there are outstanding bonds that have been issued to construct local roads, and data compiled by the bureau show that at the close of 1929 there was about $1,826,924,000 of such bonds outstanding. Unfortunately, the bureau is not in possession of the data with respect to the periods of maturity and other characteristics of the bonds in order that a similar analysis may be made. No doubt there were many cases in the early history of highway development where bond funds were either improvidently expended or the structures created could not be expected to outlive the period of the bonds, but today such cases are exceptional and of small relative importance.

Taxes not confiscatory

Statements are often presented to illustrate how rural highway assessments confiscate the farmer's property. In one periodical it is stated that the Farm Bureau is now working to correct this particular injustice and many similar ones.

The illustration given is a tract of 26 acres of farm land near Cleveland, Ohio, and in the same county where Cleveland is located. The tract is located on the Brookpark Road, which is 40 ft. wide and has a concrete base and brick surface.

There was once a law in Ohio that permitted assessments to be made against abutting property for the improvement of state roads. The information is that this law has been repealed and that instances of this character merely refer to some of the sporadic and ill-advised efforts put forward in the earlier days when the development of highway facilities was largely a matter of political experiment. No purpose can be served in agitating this system at this time, for the reason that no state follows any such policy.

In the illustration it is noted that the assessment against this property was at the rate of $28,720 per mile. Presumably the abutting property on the opposite side of the road was assessed at the same rate, which would make the total contribution of property immediately abutting $57,440 a mile. This would no doubt cover the total cost of a road of the character described.

A procedure of the character indicated would not only be most unusual but would be one that has been today universally condemned. Also it is significant that the tract of land in question constituted a narrow strip with a depth of only 400 or 500 ft. and a frontage of 2,300 ft. Had it been an ordinary farm extending back from the highway for a substantial distance, the assessment per acre would present quite a different picture. The very fact that the 26 acres would stand an assessment of more than $400 per acre is sufficient indication that it is not ordinary farmland. The proximity of a city of more than a million inhabitants determined its character. Such illustrations can only confuse any consideration of a proper policy of providing funds for the construction and support of rural highways.

California Establishes Highway Camps for Unemployed

AS A FEATURE of a state unemployment-relief program, the California division of highways has established two camps where men are given the privilege of doing part-time work on highway improvements for board and room. Each camp has a capacity for 250 men, and the sites were selected to provide sufficient opportunity for hand labor on maintaining and improving adjacent sections of highway. Men for the northern camp, in the Feather River Canyon, are supplied by San Francisco, and those for the southern camp, near Needles, are supplied by Los Angeles.

Young men in majority

The arrangement made between the cities and the division of highways provides that the cities select the men, pay their transportation to the camps, furnish clothing in particularly needy cases and assume responsibility for medical care in case of sickness. The state furnishes shoes, socks and gloves to men who remain in the camp more than four days. The applicants must be American citizens and must go to the camps voluntarily. In return for board, room and an issue of tobacco, the state requires six hours of work a day on the highway. Refusal to perform the required amount of work results in being dropped from the camp.

Most of the men sent to the camps are equal to or above the average type of laborer found in construction camps. The majority are young, the city authorities believing that the younger men will be the first to get into trouble when unable to find work. Six weeks' operation of the northern camp showed that only 50 left the camp out of the 300 sent.

What they are doing

Men in the Feather River camp are opening up a grade trail on the line of a new highway location in the canyon. The rock is drilled by pneumatic drills (two compressors are in use), but the material is moved by wheelbarrows or hand-pushed industrial cars. At the camp near Needles the men work on widening sharp curves in the present highway and in building 1 mile of changed line. All material is moved in wheelbarrows.

Buildings in the northern camp are of wood construction, and the houses accommodate sixteen men. The climatic conditions in the southern camp permit tent construction with wooden floors and screen walls, accommodating a total of eight men. In both camps the quarters are heated by stoves and electrically lighted. The state provides cot, mattress, blankets, pillow, and meals of the same type served in all state camps. Hot showers are provided and facilities for washing clothes. The state maintains a male nurse in each camp, to take care of first-aid cases.

A. N. Lund and E. S. Gripper are superintendents of the northern and southern camps. The program is being carried out under the direction of C. H. Purcell, chief engineer, division of highways, under the general direction of Col. Walter E. Garrison, director of public works.

Treated-Timber Highway Bridges

Wyoming is making extensive use of treated-timber highway bridges. Comparative studies for a 100-ft. bridge indicate the following costs: (1) standard treated-timber type $4,000; (2) reinforced-concrete deck girder, three spans, $11,000; and (3) low-truss steel, single span, $12,500. The timber structures are estimated for a life of 30 years. Asphalt planking is the standard wearing surface provided. The reasons for adopting timber and the benefits derived are outlined in the annual report of Z. E. Sevison, state highway superintendent:

Using treated timber for the 100-ft. bridge, $7,600 is immediately diverted from bridge building to road construction. In other words, at $10,000 per mile approximately 0.76 mile of additional highway can be completed in any one year for each 100 ft. of timber bridge installed.

Records show that some 28,000 lin.ft. of treated-timber bridges have been built to date, and therefore, due to this fact, we now have completed over 200 miles more of the primary road system than would have been possible had permanent-type bridges been installed in all cases. In other words, a sum of over $2,000,000 has been diverted from bridge to new road construction.

How Wire-Rope Construction Affects Selection

Better understanding of wire-rope types and their relative resistance to load, bending, abrasion and crushing will make possible important savings in wire-rope bills

By A. S. Rairden

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A REVIEW of engineering literature reveals very little information on wire rope that helps the user to acquire a better understanding of the product and its proper applications. The few scattered articles available deal with specific problems, so that their usefulness is limited. This article is planned to correct this condition in some degree by presenting, for the user of wire-rope, information gathered through several years of experience in manufacturing wire rope and applying it to various types of equipment. The important physical characteristics of wire-rope types, their method of manufacture and the factors that influence the selection of wire rope for various fields of service are all considered in some detail.

Manufacturing wire rope

The manufacture of wire rope may be subdivided into three main operations: (1) spooling; (2) stranding; and (3) closing.

In the spooling operation the rope wire is transferred from a coil to an iron spool or bobbin that is later loaded into the stranding machine. The spooling equipment (Fig. 2) consists of a free-revolving table on which the coil of wire is laid and held in position by a center section of the table that protrudes through the center of the coil in the shape of a truncated cone. The wire from the coil is threaded through a distributing mechanism that distributes the wire evenly over the face of the bobbin drum, which is caused to revolve at a uniform rate of speed.

In the stranding operation a combination of different sizes of wire previously wound on bobbins during the spooling operation are twisted together in a predetermined uniform geometrical arrangement forming a round strand. The wires are led toward the front end of the stranding machine (Fig. 3), where they are threaded through holes located in concentric circles in the twister-head, a plate usually about 6 to 12 in. in diameter and ½-in. thick. From the twister-head the several layers of wires are made to converge at one point, forming conical shapes between the plate and what is ordinarily termed the point of twist. At this converging point the wires are held together and pulled through a round hole in a hard steel die at a uniform rate of speed. The combination of revolving the stranding machine and pulling the wires out of the machine at uniform rates of speed produces the effect of twisting the one or more layers of wires around the center or core wire in helical paths.

The stranding machine, circular in shape, contains within it several cradles which, either by mechanical means or by proper counterweighting, are forced to maintain a fixed relative position with respect to the axis of the stranding machine as it revolves. This positioning of the cradles is necessary to minimize the accumulated twist or torsional forces in the wires as they are being twisted together. The bobbins filled with rope wire are placed in the cradles free to revolve and with their axes at 90 deg. to the axis of swing of the cradles.

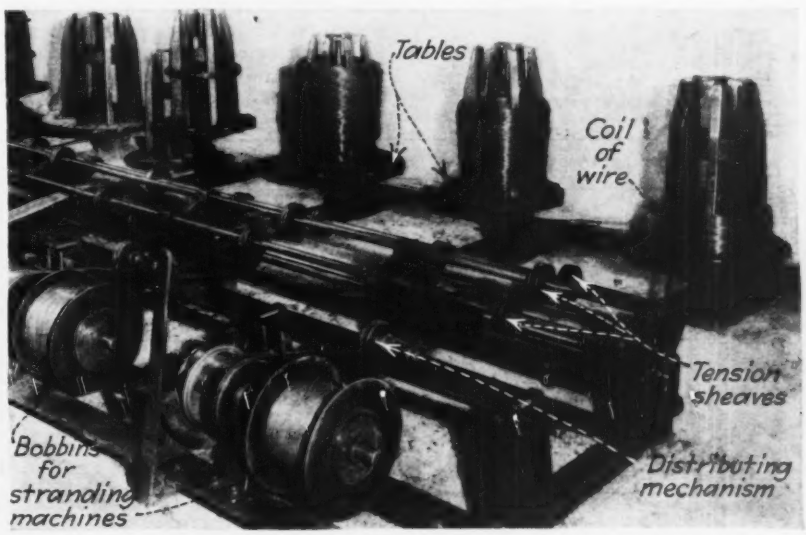
The finished strand as it comes from the stranding machine is wound several times around one or two drums ordinarily termed the haul-off drums, which keep the strand moving at a uniform rate of speed. From the haul-off mechanism the strand is threaded through a mechanism that distributes the strand evenly over the face of a large iron spool or bobbin, which is later to be loaded in the closing machine.

The closing operation, in principle, is similar to the stranding operation except that strands instead of single wires are twisted around a central member or core, with a uniform length of lay or pitch. Usually the strands are six or eight in number and the core is either a hemp rope or a small independent wire rope.

A recent improvement of the closing operation permits the preforming or preshaping of the strands and wires composing the strands by passing the strands over rollers of the proper diameter and so positioned relatively to one another that the resultant strand assumes the exact helical shape that it will occupy in the finished rope. This operation also removes practically all torsional or untwisting forces ordinarily encountered in non-preformed wire rope, as can be demonstrated by cutting preformed wire rope and noting how the wires and strands remain in their normal position. In cutting non-preformed wire rope, unless the end is seized with a firm wrapping of wires,

Fig. 1—In regular-lay rope (right) lay of wires is opposite to lay of rope and axes of outer wires are parallel to axis of rope. In lang-lay rope (left) lay of wires and of rope is in same direction and axes of outer wires make an angle of 37 deg. with the axis of the rope.

Fig. 2—Spooling, the transfer of the rope wire from coils to a steel spool or bobbin that fits into the stranding machine, is the first operation in wire-rope manufacture.



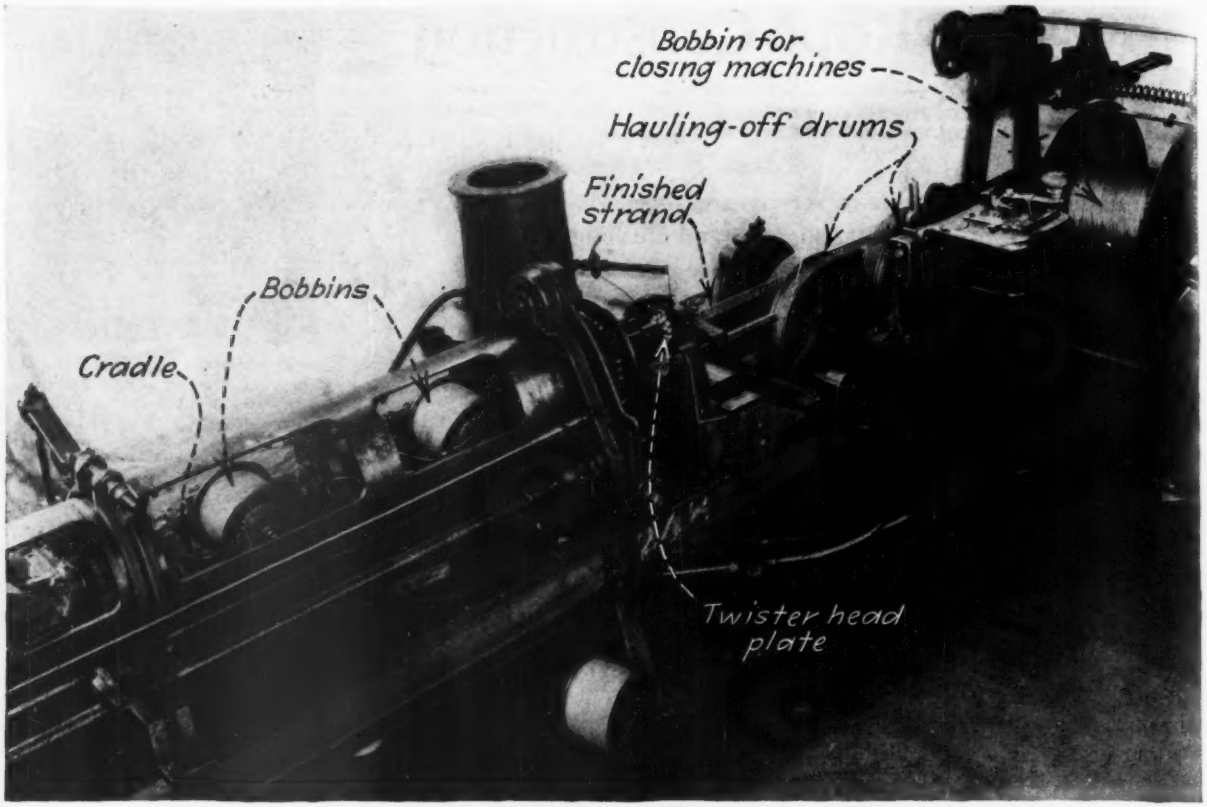


Fig. 3—Wire-rope strands are made by twisting wires of various sizes, which have been wound on bobbins during the spooling operation, around a core wire. The strands as they leave the machine are wound on a large bobbin which later is fitted into the closing machine.

the strands and wires straighten out and fly apart like a suddenly released clock spring.

Wire rope types

A *wire rope* may be considered as possessing a perfectly symmetrical cross-section consisting of six or eight strands twisted helically around a hemp or wire rope core with a uniform length of lay or pitch in such a manner as to distribute the strands around the axis of the rope uniformly.

A *strand* consists of concentric interlocking layers of wires twisted helically around a steel wire or hemp core with a uniform length of lay or pitch in such a manner as to distribute the wires around the axis of the strand uniformly.

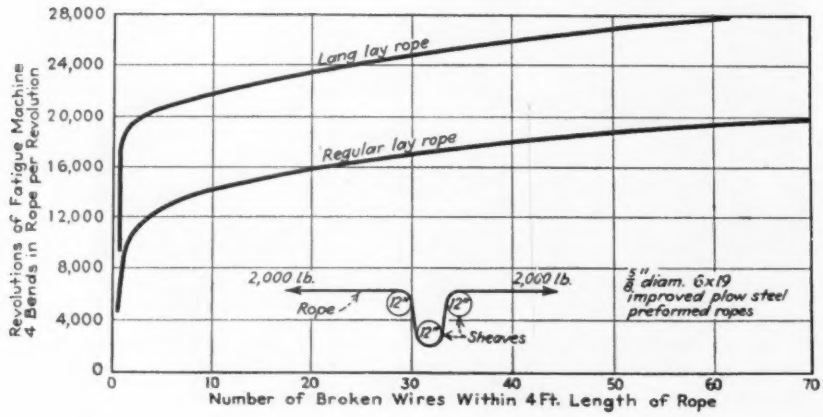
Length of lay is the distance parallel to the axis of a rope or strand between two identically positioned points on one strand or on one wire in making one complete revolution around the rope or strand axis.

In *right-hand lay* the wires or strands pass from left to right across the top of the strand or rope while receding from the observer. In *left-hand lay* the wires or strands pass from right to left across the top of the stand or rope while receding from the observer.

Finished wire rope is made in two types of lay—that is, regular lay and lang lay (Fig. 1). In *regular-lay* the direction of lay of the wires in the strands is opposite to the direction of lay of the rope; in *lang-lay* rope the direction of lay of the wires in the strands is in the same direction as the lay of the rope. Comparing regular-lay rope and lang-lay rope in Fig. 1, we may observe the following important features:

1. In the regular-lay rope the axes of the outer wires on the crowns of the strands run parallel to the rope axis.
2. In the lang-lay rope the axes of the outer wires on the crowns of the strands lay at an angle of about 37 deg. with respect to the axis of the rope.
3. The length of the outer exposed wires on the crowns of the strands of the regular-lay rope is about one-third the length of those in lang-lay rope.

Fig. 4—Life curves of regular and lang-lay wire rope obtained in fatigue tests over sheaves as shown.



Stress and length of life

When a wire rope is bent and travels over a sheave, bending stress is developed in the wires. In regular-lay rope the bending moment reacts directly along the axis of the outer wires, whereas in the lang-lay rope the bending moment must be translated through an angle of 37 deg. to react along the axis of the outer wires, which translation decreases its magnitude slightly. Since the bending moment in a lang-lay rope reacts along a length of exposed outer

wire about three times as long as the length of exposed outer wire in regular-lay rope, the bending fiber stress is therefore less in the lang-lay rope, which gives this type of rope a greater length of life in sheave service.

Life curves of rope (Fig. 4) depict the relative behavior of lang-lay and regular-lay ropes tested on a machine in which the ropes are passed back and forth with severe reverse bends over three 12-in. sheaves. The greater length of life of the lang-lay rope is evident. For example, with 30 broken wires in a 4-ft. length the lang-lay rope life is 147 per cent of the regular-lay rope life.

In the past a lang-lay rope has not been regarded with much favor because of the unusual amount of pent up torsional stresses present. The rope kinked and curled easily and was extremely hard to handle during installation. This objection is now overcome by the preforming process, which causes the rope to lie straight at all times, with no tendency to kink or loop. It has made the installation of lang-lay ropes just as easy as regular-lay ropes, and has made possible the utilization of the long-life characteristics of lang-lay ropes in service.

Certain disadvantages of lang-lay rope must be noted, however. First because of its construction it does not resist crushing as readily as regular-lay rope, and lang-lay rope should never be used on installations where the hoisting drum does not permit uniform and even winding. Lang-lay rope is preferably not to be used where the rope overwinds in more than two layers on a hoisting drum. Second, because the lay of the wires in the strands and the strands in the rope is in the same direction, the tendency for the rope to unlay or untwist is much greater than in regular-lay rope. It is recommended that lang-lay rope be used only when both ends of the rope are permanently fixed during service.

During service wire fiber stresses in a rope may be subdivided into: (*a*) tensile stresses; (*b*) bending stresses; and (*c*) torsional stresses.

A non-preformed wire rope running over sheaves with an applied tension will be subject to failure resulting from all the above-mentioned stresses. On the other hand a preformed wire rope is subject only to tensile and bending stresses and the wires fail much later in service. The effect is shown by a plotting of numerous life tests conducted in the research laboratories of the American Cable Co. (Fig. 5).

Constructions of wire rope

In Fig. 6 are shown the most common constructions of wire rope. The cross-sections show both six- and eight-strand ropes containing hemp cores, and for ready comparison strands of various constructions are included within the same wire-rope cross-section. The wire sizes are all to the same scale so that comparisons may readily be made.

The important factors influencing the choice of the size, grade and construc-

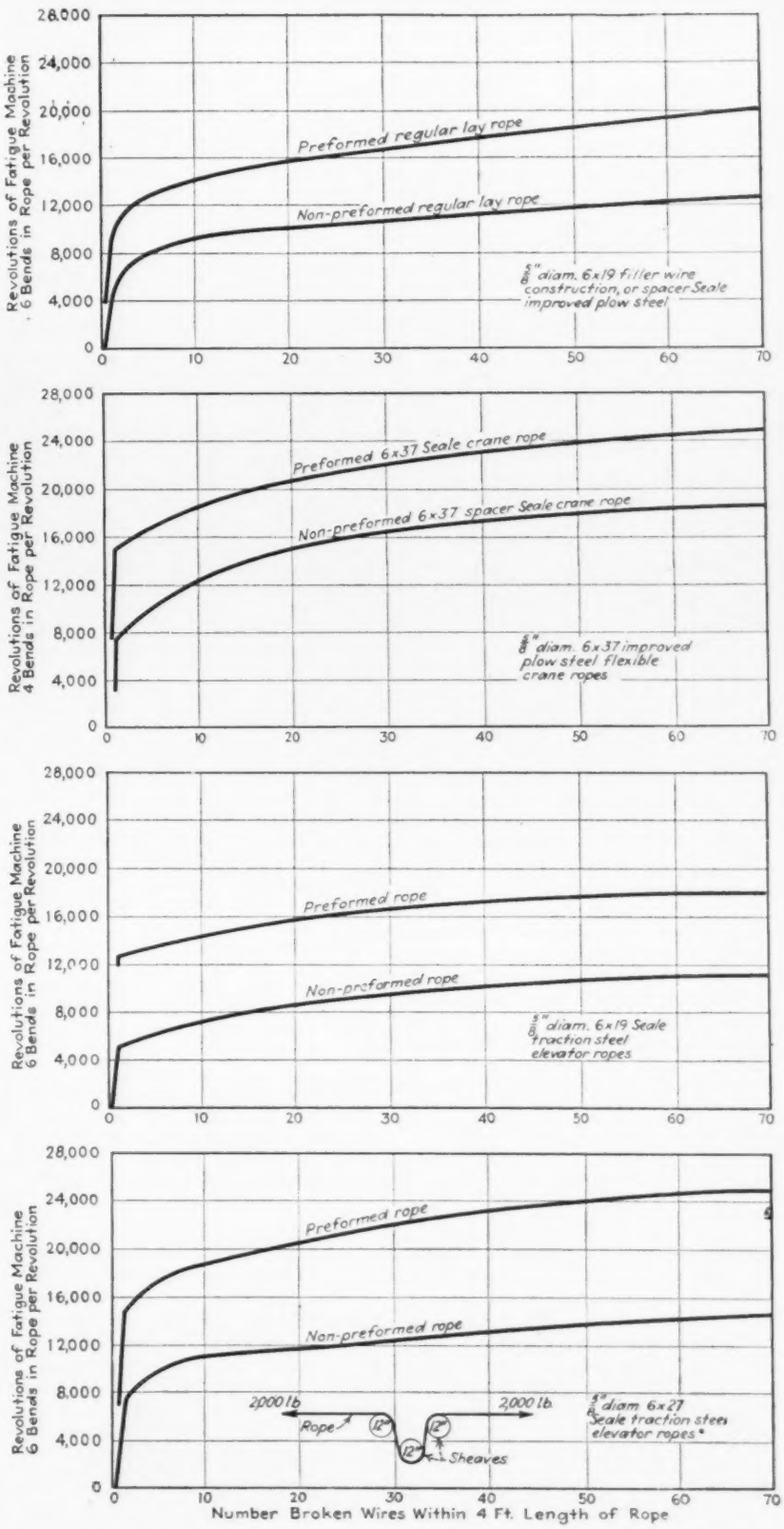


Fig. 5—Comparative life curves of preformed and non-preformed wire rope of various constructions obtained from numerous tests conducted in the research laboratories of the American Cable Co.

tion of rope to be used may be briefly enumerated as follows: (*a*) stress or load on rope; (*b*) resistance to bending fatigue; (*c*) resistance to abrasion; and (*d*) resistance to distortion or crushing.

Stress—The stress or load on a wire rope on a hoist may readily be computed using simple laws of physics by determining the weight of the load lifted, the angularity of lift, the maximum linear speed at which the load is lifted, the rate of acceleration or deceleration of hoisting, and the load applied to the rope due to friction.

Static tension may be easily figured by the formula:

$$T = W \sin a$$

T = static tension of rope (lb.)
a = angularity of lift (deg.)
W = weight of load (lb.)

The added tension due to acceleration may be calculated by the formula:

$$F = m\,a$$

F = tension (lb.)
m = weight of load (lb.) divided by 32.2
a = acceleration in ft. per sec. per sec.

$$a = \frac{v}{t}$$

v = maximum linear velocity, ft. per sec.
t = time (sec.) necessary to bring load from state of rest to the maximum speed.

The tension due to friction (f) may be closely estimated or found by the use of empirical formulas and the total tension on the rope will be equal to $(T + F + f)$ lb.

In bending around sheaves of normal diameter, (discussed later) a wire rope loses about 5 per cent of its breaking strength due to the bending fiber stresses set up in the wires, and this should be taken into consideration before the final choice of rope is made. To obtain the required breaking strength the tension on the rope should be multiplied by the desired factor of safety, usual values of which are:

For static loads	4
Hoisting or hauling loads	6
Hoisting or hauling passengers	10
Hot ladle cranes	10

After finding the desired breaking strength from manufacturers' catalogs, the user can determine the grade of wire rope to be used if the size is restricted by the sheave and drum sizes and grooving. Or he can determine the size and grade of wire rope required to accommodate the capacity of his hoisting drum or to fit in with other economical considerations of construction or equipment.

Bending Fatigue — Resistance to bending fatigue is dependent upon the grade (measured by tensile strength) and the size of the outer series of wires in each strand of the rope. Common grade standards of rope wire are:

	Lb. per Sq. In.
Cast steel	180,000 to 200,000
Mild plow or extra strong cast steel	200,000 to 230,000
Plow steel	210,000 to 250,000
Improved plow steel	240,000 to 270,000

The accompanying table of normal sheave diameters has been compiled, taking into consideration that the resistance to bending fatigue is inversely proportional to the tensile strength (and in turn to the carbon and manganese content of the steel), and to the size of the outer wires in each strand.

Crushing Strength—Resistance to distortion or crushing is inversely proportional to the number of strands in the rope and to the number of wires per strand.

Comparison of cross-sectional cuts of the six-strand rope with the eight-strand rope (Fig. 6) bring out the relatively much larger body of hemp in the latter. The eight-strand rope will distort much more readily due to the application of crushing forces such as radial pressure of the rope traveling over a sheave or overwinding of the rope on a hoisting drum. Distortion of symmetry of cross-section is always accompanied by the creation of uneven distances between strand centers and the axis of the rope, and as soon as this happens the load distribution between strands becomes uneven.

On hoisting equipment severe distortion of constructional symmetry is frequently caused by the rope winding on the hoisting drum in criss-cross fashion. The machining of spiral grooves on the face of a hoisting drum, compelling even winding, prevents distortion of the rope and increases its length of life.

SHEAVE-SIZE CONSTANTS FOR VARIOUS WIRE ROPE CONSTRUCTIONS
Normal sheave or drum diameter equals the constant multiplied by the rope diameter

Grade	6x7	6x17 Filler Wire	6x19 Seale	6x21 Filler Wire, 6x19 Warrington	6x19 Filler Wire, 8x19 Seale	8x19 Warrington, 6x29 Filler Wire	8x19 Filler Wire, 6x33	6x37
Cast steel	36	32	28	25	22	21	18	15
Mild plow	40	35	30	28	24	23	20	17
Plow	43	38	34	30	26	25	22	18
Improved plow	48	43	37	33	29	28	24	20

Abrasion — Resistance to wear is directly proportional to the tensile strength and to the size of the outer wires in each strand. Brinell hardness comparisons of the common rope wire grades manufactured may be made from the following table:

Grade	Brinell Hardness
Cast steel	380
Mild plow	415
Plow	445
Improved plow	460

Within the same grade the common construction of wire rope may be listed in the order of the greatest resistance to wear to the least resistance to wear in accordance with the table on p. 291.

Depths of grooves should be about 40 per cent of the nominal rope diameter, and the contour of the grooves should conform to the nominal diameter of the rope plus proper recommended clearances as follows:

Diameter Rope	Tolerance of Groove Diameters
½ in. and smaller	+ 1/32 in. min. to + 1/16 in. max.
9/16 in. to 1 in.	+ 1/16 in. min. to + 1/8 in. max.
1 1/16 in. to 2 in.	+ 3/32 in. min. to + 1/16 in. max.
Larger than 2 in.	+ 1/8 in. min. to + 1/4 in. max.

The greater the number of wires in a strand the greater is the tendency of the wires to slide by one another with the application of a compressive distorting force. Extremely flexible constructions such as 6x33 and 6x37 rope should

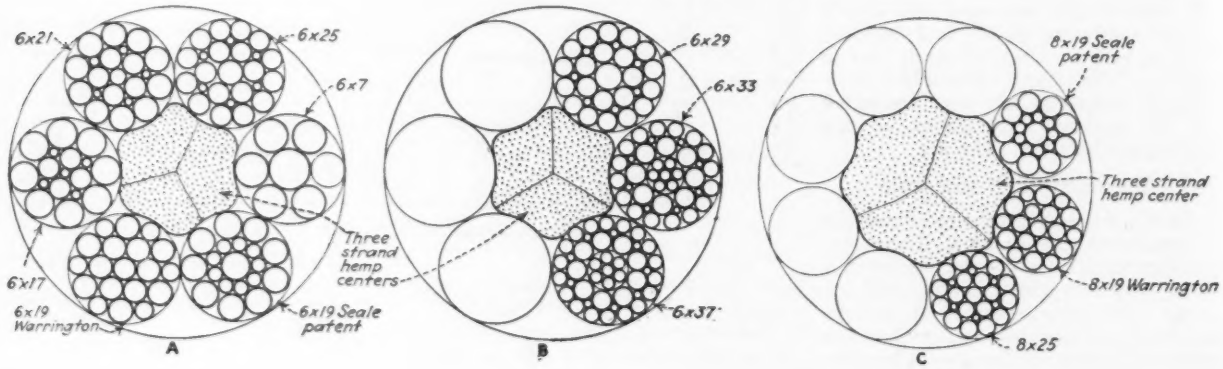


Fig. 6—Typical six and eight-strand wire ropes with strands made up in various constructions for comparison.

WIRE ROPE TYPES FOR COMMON FIELD APPLICATIONS
Ropes listed in order from greatest to least resistance to wear

Constructions	Common Field Applications
6x7 (most resistant to wear)	Cable tool drilling lines; bailing or sand lines or drilling rigs; sash cords.
6x7 lang-lay	Haulage systems with large sheaves and drums; cableways.
6x17 filler wire regular-lay and lang-lay	Haulage systems; mine inclines.
6x19 Seale regular-lay	Skidder lines and sky lines in timbering operations; mine inclines.
6x19 Seale lang-lay	Haulage systems; mine inclines; cableways.
6x21 filler wire, regular-lay	Haulage systems; mine hoists.
6x21 filler wire, lang-lay	Haulage systems; mine inclines.
6x19 filler wire regular-lay	General utility hoists; elevators; derricks, clamshell buckets; tackle blocks; mine hoists.
6x19 filler wire lang-lay	Mine hoists; shovels.
6x19 Warrington regular-lay	Mine hoists; elevators; cable tool drilling.
8x19 Seale regular-lay	Hoists; elevators.
6x29 filler wire, regular-lay	Hoists; mill cranes; clamshell buckets.
6x29 filler wire, lang-lay	Mine hoists; shovels.
8x19 filler wire, regular-lay	Light-duty hoists; elevators.
8x19 Warrington regular-lay	Light-duty hoists; elevators.
6x33 regular-lay	Mill hoists.
6x33 lang-lay	Shovels.
6x37 regular-lay	Mill hoists.
6x37 lang-lay (least resistant to wear)	Shovels.

therefore preferably operate without overwinding on a hoisting drum.

Radial crushing forces within a wire rope, created by the application of the load, may become so great that the hemp fibers will shear and pulverize, destroying all support to the strands. When this happens fatigue bending stresses are magnified on the crowns of the strands due to the strands coming together and crowding one another. Premature failure is usually the result of overloading wire rope. Frequently this happens even before the elastic limit of the steel in the rope has been reached. To overcome complete collapse of the hemp core at radial pressures of approximately 8,000 lb. per sq.in. it becomes necessary to replace the hemp core by an independent wire rope core—a small wire rope within a wire rope.

Conclusion

From the discussion of the controlling factors that govern the choice of a wire rope, by the process of deduction and elimination the proper selection of wire rope becomes a comparatively easy problem. If, after selection, accurate records are kept on the behavior of the rope during service and also on the ultimate service rendered, it is not very difficult to make large and important savings in the wire rope bill.

Brittleness From Punching In Galvanized Structural Steel

REPORTS of galvanized structural-steel angles breaking with a brittle fracture through a bolt or rivet hole and the failure during erection of a large electrical transmission tower led to systematic research of the problem at Battelle Memorial Institute, Columbus, Ohio, by the Utilities Research Commission and the American Society for Testing Materials. Begun in 1930, these studies were later merged, and the work is now being sponsored by a large number of steel producers, fabricators and consumers.

Angles in different sizes and in different grades of steel from some 130 heats have been tested, a total of more than 3,000 tests. No material has been found that is ductile in the black but brittle after pickling and galvanizing, and no direct proof has appeared that it exists. On the other hand (although in the last year and a half not a single failure due to brittleness in a transmission tower or other similiar structures has been reported, indicating the great rarity of dangerous embrittlement), the study has shown that in fabricating and galvanizing factors arise which, if not understood and guarded against, may make angles brittle. It is not easy to say how much ductility is needed in service after a tower has been put up, but undue brittleness may result in a failure during erection. Such brittleness (failure with little or no deformation at the fracture) is not revealed in the ordinary tension test or even in the notched-bar impact test on unworked material, but it shows up, if present, when an angle with a hole punched near the toe of one of the legs is tested in the "'e bend test." The secret of the different behavior in the punched-hole angle bend test from that in the ordinary tests undoubtedly lies in the cold work produced about the punched hole. Impact tests of cold-worked specimens show similar brittleness. The tearing and cracking that occur about the punched hole may contribute toward brittle behavior, but the test data indicate this effect to be slight in comparison with the effect of cold working. With drilled or subpunched and reamed holes no severe brittleness is encountered except in large bessemer-steel angles.

The thicker the angle the greater the effect of punching and the greater the likelihood of brittleness. The coarser grain size in the larger angles also promotes brittle behavior. In the tests made, brittleness was not found in open-hearth angles less than ½ in. thick, very infrequently in ½-in. angles, but rather frequently in 1-in. angles.

The incidence of brittle behavior increased markedly on lowering the testing temperature, so that the data tended to corroborate reports of angles breaking with a brittle fracture during construction in freezing weather.

Compared to punching, both pickling and galvanizing may be classed as minor embrittlement factors, although not entirely negligible ones, for quite often the larger angles are brought so near the verge of brittleness by the punching operation that the slight additional effect of pickling or galvanizing is enough to throw the balance toward brittle behavior. The embrittlement in pickling appears to be due to hydrogen absorption and wears off after standing several days. That in galvanizing appears to be due mainly to an effect that is now receiving a good deal of attention from research workers in metallurgy—namely, heating to blue heat after cold work (the cold work being due to punching the hole).

Indicated remedies for embrittlement are drilling or subpunching and reaming larger-sized angles, heating to a high enough temperature after punching to eliminate the cold-work effect, or the development of a steel less susceptible to embrittlement in punching and galvanizing.

At present the study is being directed mainly toward standardizing the angle bend test and comparing it with a somewhat similar "hole tensile test," in which a coupon cut from the angle with a hole in it is tested in tension. Further work is also in progress on ascertaining more definitely which chemical elements are mainly responsible for embrittlement in structural steel.

Abstract of progress report to A.S.T.M.

Nitriding Overstrained O.H. Steel

Flow lines in steel that has been stressed beyond the yield point are brought out by the Fry method of etching, if the steel contains a small amount of nitrogen—between 0.01 and 0.05—but not outside these limits. Bessemer steel usually contains nitrogen within these limits, as does also weld metal, but open-hearth steel is lower in nitrogen and therefore could not be studied by this etching method. It has now been discovered by F. R. Hensel and C. W. MacGregor, of the Westinghouse Electric and Manufacturing Co., East Pittsburgh, that the etching method may be used with open-hearth steel if the steel is nitrided. The best procedure is to cut sections, exposing the faces to be studied, after the material has been overstrained, then give it the nitriding treatment, and finally etch it, which brings out the flow lines and strain patterns.

Economies in Dams Designed for Increase in Height

Designing and building foundations and substructures of dams with provisions for adding to the height in the future leads to major economies when increased capacity is needed

By Calvin V. Davis
Chief Designer, Ambursen Dam Co., New York, N. Y.

COMPLETION of the work of adding 30 ft. to the height of the Bristol dam of the Utilities Power Co. on the Pemigewasset River in New Hampshire serves to emphasize the economic possibilities of providing for an increase in the height of a dam when it is first built. The Bristol dam was built in 1924 to a height sufficient to develop a head of 55 ft. with 5-ft. flashboards, a head sufficient for the existing load requirements of the power system (*ENR*, Aug. 18, 1927, p. 264). However, as development of the full possibilities of the site called for a dam producing a head of 80 ft., the buttresses of the dam as built were designed for a dam of the greater height, and in the power-house section the buttresses for the high dam were carried up to a point where the raising of them would not interfere with the operation of the plant. In this way the cost of raising the dam was greatly reduced, with little increase in cost over that which would have been required for a dam to develop the low head.

Application of this principle to the design of many dams presents possibilities for major economies when expansion of the service, either power or water supply, becomes desirable. Obviously, it cannot be applied to all dams because many are built to their economic height limit at the start. On the other hand, recognition of the economic possibilities of two-stage construction might have reduced the initial investment in such structures. That fact indicates the desirability of fuller understanding of the underlying principles involved in designing dams for a future increase in height.

Designing methods

Aside from crest gates and similar devices, the following methods have been used to increase the initial height of gravity dams:

1. Joining to the downstream face an additional gravity section, which is (1) independently stable, (2) properly drained so that water pressure cannot exert an overturning force along the joint, and (3) properly bonded and keyed to the initial construction.

2. Extending buttresses from the downstream face of the dam that are designed both to reinforce the original mass-concrete construction and to carry the additional load from the extension.

3. Building all parts of the initial structure to the full horizontal dimensions required for the completed structure.

The third method may be combined with the first or second as conditions at the site dictate.

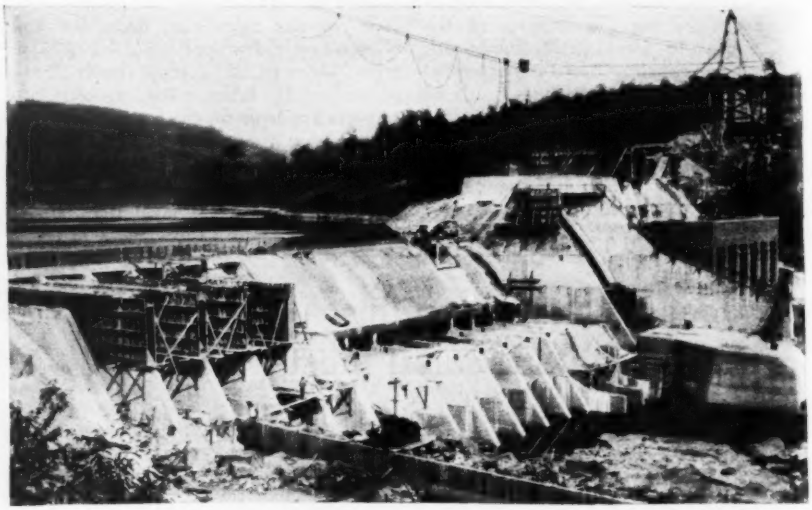


Fig. 1—Thirty feet were added to the height of Bristol dam, in New Hampshire, without interfering with the operation of the plant.

Both the second and the third methods described are applicable also to buttress-type dams, although the second is in more common use. Further, an existing gravity dam may be increased in height and greatly strengthened by the construction of a buttress-type dam as a downstream extension of the original structure, as was done at the water-supply dam for Danville, Ky.

In designing extensions to both types of dams modern methods of stress analysis aid materially in determining the correct outlines for the inclined downstream columns or buttresses. By these methods of analysis the joints between the various extensions may be located along planes giving minimum interference with the monolithic character of the structure as a whole.

The first analytical step is an accurate and comprehensive study of the stresses and their directions in the ultimate structure treated as a monolith. It is necessary to go much farther than the usual procedure of determining vertical pressures on horizontal planes by the law of the trapezoid, as the results obtained by this older method do not indicate the true loading-stress conditions within the dam. In order to study the stress conditions properly at the joints between the adjacent sections of the dam it is necessary to carry the analysis to a determination of the first and second principal (maximum inclined) stresses and their directions and the shearing-stress intensities throughout the structure. These stresses may be found by the methods developed by the late William Cain and perfected in recent years by F. A. Noetzli, B. F. Jakobsen and others.

The directions or trajectories of principal stress, as so determined for both a gravity and a buttress-type dam, are shown by Figs. 2 and 3. The directions of first principal stress for both structures follow well-defined curved trajectories normal to the upstream face of the structure and asymptotic to the downstream face. The trajectories of the second principal stress are at all points normal to those of the first principal stress. As these trajectories are determined from a definite mathematical procedure, it is evident that a masonry dam consists of a series of elementary curved inclined columns, each transmitting a portion of the load from the upstream water-bearing face through the structure to the foundation.

An important property of these trajectories is that they are planes of zero shear under maximum loading, which means there is no tendency for relative movement between the elementary columns when the reservoir is full; a curved joint such as *A-A* (Fig. 3) could be cut along any trajectory plane without disturbing the equilibrium of the structure as a whole under full-load conditions.

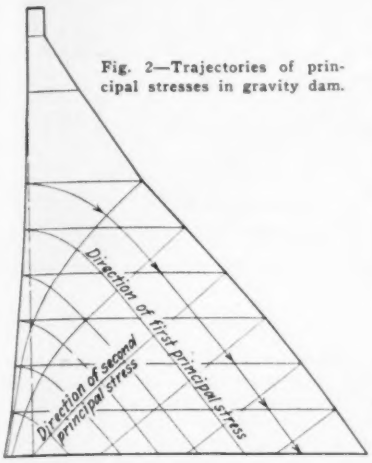


Fig. 2—Trajectories of principal stresses in gravity dam.

The foregoing clearly indicates the application of the principal stress analysis to the design for a dam to be raised at some future time. Assume, for example, that H_1 (Fig. 3) represents the height of the initial construction. The downstream face of this part of the dam would then be constructed along the trajectory plane *A-A*.

When the dam is extended to height H_2 through the addition of an inclined column downstream of *A-A*, the stress distribution for full-load conditions will not be greatly changed because of the joint as there will be no tendency for the extension to move along the plane of the joint in relation to the initial construction.

While the principle above emphasized is of prime importance, other tests should be applied. These are: (1) the preparation of independent stability computations for each of the columns defined by the inclined joints; and (2) the investigation of the stresses along the joints under a varying reservoir level.

Fig. 4 shows a graphical check of the stability of the columns downstream of the joint *A-A* (Fig. 3). This analysis, prepared independently of the structure upstream of the joint (second principal stresses neglected), shows that the column is stable and generally tends to bend in an upstream direction. A similar graphical analysis taking into account the distribution of the second principal stresses along the joint would show that the pressure diagrams coincide with those for the entire structure when analyzed as a monolith.

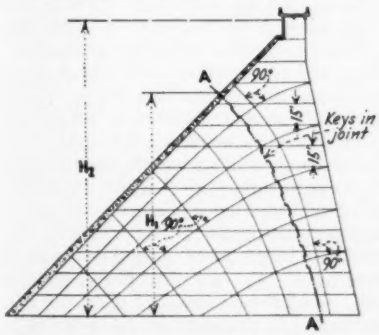


Fig. 3—Trajectory of principal stresses in buttress dam.

The effect of part loading on the stresses along the joints must now be considered. The trajectories of first principal stress under full-load conditions are not planes of zero shear as the reservoir is drawn down. However, the shearing stresses developed along the joints under part loading are of relatively low intensity, easily provided for by shear keys, as shown by Fig. 3.

Means for bonding the various units of the dam together are desirable in order to insure the monolithic action of the srtucture as a whole under all loading conditions. Steel dowels with grooves and keys between the joints will be found satisfactory.

To summarize the design requirements for dams to be constructed to increased heights (through the addition of inclined columns downstream of the initial construction), the following may be stated: (1) the component columns must be independently stable under maximum loading conditions; (2) the component columns of mass construction must be properly drained to prevent the building up of a heavy overturning pressure; (3) the planes between adjacent columns must be as nearly possible planes of zero shear under full-load conditions; and (4) provision must be made for bonding and keying the columns together in order to insure monolithic action in the completed structure and to transmit shearing stresses across the joints under partial loading conditions.

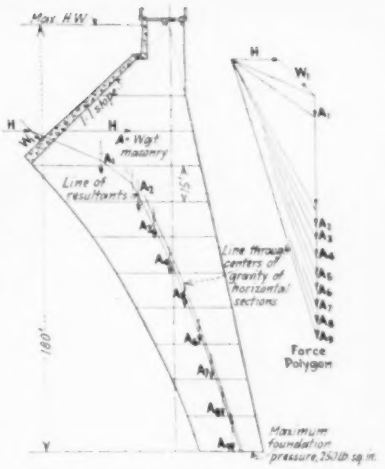


Fig. 4—Forces determining the stability of a downstream column.

Sealing a Leaking Reservoir In Italian Appenines

Crevassed and permeable rock in reservoir of hydro-electric plant on the River Ripa resisted waterproofing operations until virtually lined with gunite

By B. C. Collier

President, Cement Gun Co., Inc., Allentown, Pa.

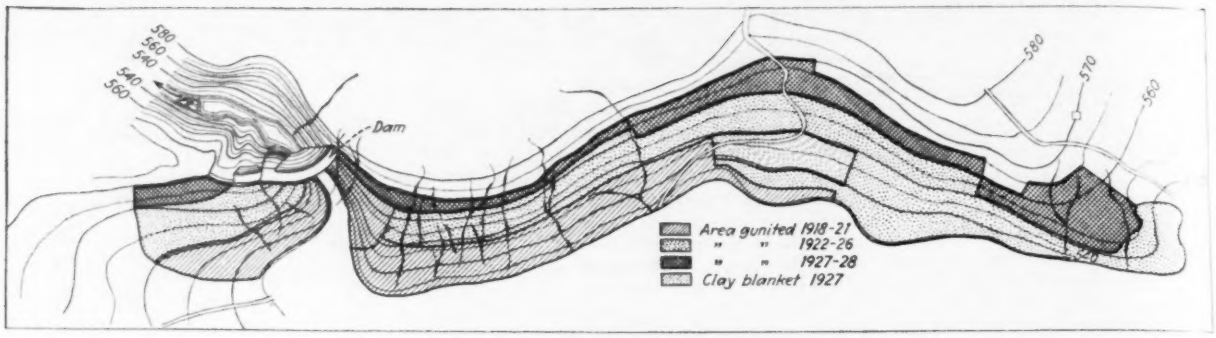
THE FOLLOWING ACCOUNT of notable difficulties in sealing a leaky reservoir is condensed from an article by engineers Mario Mortara and Vincenzo Buttiglione in the *Annali dei Lavori Pubblici, Gia Giornale del Genio Civile*, the official gazette of the civil engineering service of the Italian government. —EDITOR.

IN 1914 work was begun on a dam across the canyon of the River Ripa near the town of Muro, in the mountains of south-central Italy. The dam was completed in 1916, but when filling began, the leakage through the walls of the canyon was so great as to prevent operation and create a dangerous condition. Surface examination of the basin prior to construction had shown that the rock surface generally was covered with a clay or sand deposit that seemed to indicate impermeability.

The dam has a gravity-arch section about 30 meters long, with a top elevation of 570.75, and a total height above the bed of the stream of 47 m. Construction provided for a diverting dam about 5 m. high across the valley, and a diverting pipe through the dam proper. Work progressed without incident to an elevation of 550, when an extraordinary flood overtopped the diverting dam and exposed a crevasse in the almost vertical walls of the canyon. This crevasse appeared in a very short zone at the upper corner of the dam, and when the water reached El. 535 it closed, allowing the water to rise to a greater elevation.

Work was stopped, and careful examination disclosed that the rock itself was absorbing considerable water and that the hydraulic head had opened fissures. These crevasses had been filled with the same clay deposit that existed in the valley bottom, but as they widened out at greater depth, the hydraulic head forced out this deposit, leaving a direct opening and drain from the basin.

An effort was made to effect repairs by covering the first crevasse with an elastic membrane of mesh and waterproofing materials, and by placing an



Location of crevasses and areas of gunite lining in waterproofing Italian reservoir.

additional corner on the dam. The crevasse above El. 536 was filled with clay and stone was laid by hand.

Work was renewed, and in 1915 the top elevation of 570.75 was reached. When the water reached El. 546 no further progress could be made; in fact, the level began to recede. The loss was about 1,000 liters per second, and examination of the surface below El. 546 disclosed numerous crevasses.

In 1916 the basin was emptied, and work of repairing and filling the crevasses was carried on. The general method was to fill the crevasse with clay and stones, and walls were built across the mouths of the larger fractures. On refilling the basin in the winter of 1916-1917, the losses continued to be very high, and in January, 1917, during an exceptional flood, the water rose to El. 555, and the seepage loss was 1,200 liters per second; in March, 1917, the losses had increased to 1,600 liters per second.

The minister of public works then appointed a commission to report on further procedure. This report showed that not only was the loss due to the large openings, but that the character of the rock itself allowed large percolation. It also recommended a new treatment of both the fractures and the surface. Repairs were carried out during 1917, but in January, 1918, when a flood condition brought the water to El. 554, the losses noted were 2 cu.m. per second. Although the flood was introducing water at an average of 2,000 liters per second, the actual level of the lake receded 8 cm. in six hours.

A still more careful examination by a board of engineers and geologists was begun in May, 1918. This showed that while some losses were occurring through the crevasses, the principal losses were through the numerous laminated seams in the rock. It was therefore decided to abandon further filling of the crevasses and instead utilize the cement gun for placing a blanket coat over the rock surface.

Period of cement-gun operations

The placing of gunite was begun in 1919 in two coats, each about 2 cm. thick. The proportions were one cement to three sand. The rock was cleaned by removing all loose materials by hand tools and water pressure; the roughest irregularities were smoothed off by pneumatic tools and blasting; the walls built in previous repairs were removed; the fractures were cleaned (in many cases to depths of several meters), after which they were refilled with concrete. Finally, the whole surface was covered with the two layers of gunite.

These repairs, begun in 1920, progressed rapidly during the next two years, with little disturbance due to water head; but in March, 1923, a severe flood raised the water level to a point higher than the completed gunite and reopened three large fractures on the right bank and one on the left, resulting in a water loss of 2,300 liters per second. In the following May the reservoir was emptied and the fractures were repaired. In the winter of 1923 and 1924 another severe flood raised the water to El. 565, and again a severe loss (3,500 liters per second) was noted. After emptying the reservoir the cause of this loss was found to be a crevasse about 3 m. wide connected with the main fracture. These experiences caused doubt of the efficacy of the gunite repairs, but a further re-examination showed that the results below El. 560 were satisfactory when not subjected to severe hydrostatic heads from behind.

In February, 1925, work was ordered to proceed to bring the gunite to the elevation of the overflow. In the meantime, however, financial difficulties had to be overcome, and it was not until August, 1926, that these were straightened out and work renewed. Under this new arrangement the gunite was to be carried to El. 570.75, and this work was done during the years 1927, 1928 and 1929. The following quotation is from the *Annali dei Lavori Pubblici:*

> The final results proved the correctness of the process. After December, 1926, the lake was not drained, but at the end of September, 1928, it was lowered for inspection. The electrical plant was operated on part time for a while, but from September, 1929, it operated for 24 hours per day, utilizing the full capacity of the reservoir. During the past two winters the maximum capacity of the reservoir has been maintained, and during the last year the total losses, including evaporation and filtration through the dam itself, were maintained at from 200 to 250 liters per second.

TOTAL COST OF THE VARIOUS WORKS (LIRE)

Cost of dam (1914-1915)	490,000
Waterproofing work (1916-1918)	125,000
Gunite reconstruction (1918-1921)	1,125,000
Gunite reconstruction (1922-1926)	1,410,000
Gunite reconstruction (1927-1928)	700,000
Total	3,850,000

The total, in the revaluations of the lire, represents an expenditure of 1,600,000 gold lire ($308,000). The total surface of gunite was 39,000 sq.m., 11,500 of which was done during 1918 to 1921 at a cost of 98 lire per square meter, while the remaining 27,500 sq.m. cost about 69 lire. Further analysis shows the distribution of guniting costs to be in percentages:

Scraping and cleaning the rock	13
Filling and repairing crevices	37
Cleaning and leveling the surface	8
Gunite, including power, cost of machines, etc.	32
Excavating and backfilling trench at riverbed	10
Total	100

Tests of Freight Containers

Increasing use of the container system for handling small lots of freight in Europe has made it desirable to develop containers of adequate strength for safety of the contents. In competitive trials of designs for 5-ton loads, arranged by the International Chamber of Commerce, 23 competitors from several European countries submitted a number of designs, but only thirteen designs by eight competitors met the severe conditions. As all of these latter presented some defective features in the final tests, there was no general conclusion of results. The purpose of the competition was to develop containers of minimum size, weight and cost, with high durability, ease and economy of handling, ease and efficiency of attachment to car or truck, secure locking device, watertightness and facility for ventilation. The final tests included: (1) streams of water under high pressure to determine watertightness; (2) loaded containers were mounted on cars driven against a bumper block at 6 m.p.h.; (3) one end was lifted 20 in. and then suddenly dropped; (4) concrete blocks of 12½ tons weight were dropped upon the containers; (5) the containers were loaded into a ship to determine the facility of handling and stacking as cargo.

Australian Road Practice and Experiments

Particular consideration given to lower-cost construction of oil, tar and cement penetration and mixed-in-place bituminous surfaces

By T. J. Cavanaugh
Civil Engineer, Sydney, Australia

ROAD CONSTRUCTION in Australia is carried out principally by boards and commissions that have been appointed in each of the six states comprising the commonwealth, or by a local council that does the work either on behalf of these boards or in their own interest. It is to the main road boards or commissions of each of the states, however, that Australians have had to look for the setting of standards. Hence, in reviewing Australian practice the accomplishments of the three principal boards—namely, the country roads board of Victoria, the New South Wales main roads board and the Queensland main roads commission—are of paramount importance and interest.

Construction consists generally of concrete, asphaltic concrete, bitumen and tar penetration, and gravel, though in some instances sand-clay construction has been employed where materials are of good quality.

Cement penetration

Concrete construction has followed largely world practice, though for secondary roads a new type of cement penetration is being used largely during recent years. This construction as adopted in Australia differs somewhat from that in other countries, though the object in each case is the same—that is, to coat each stone throughout the road thickness with grout and to bind them together with the aid of a roller. For the purpose of this article let us consider the methods adopted by engineer W. I. Muntz at Ryde, Sydney, N.S.W.

The area, consisting of 1,592 sq.yd., was shaped roughly and covered with broken sandstone, the excavations averaging 11 in. in depth. The roadbed was then trimmed to conform with a crossfall of $\frac{3}{8}$ in. per foot and consolidated with a 12-ton roller. Side forms 8x2 in. were then fixed in position, and for half of the section a layer of 2-in. metal from $2\frac{1}{2}$ to 3 in. thick was spread. Upon this, B.R.C. fabric was laid and a further $5\frac{1}{2}$ in. of 2-in. metal was spread, making $8\frac{1}{2}$ in. of loose metal. On the second section the $5\frac{1}{2}$ in. of metal was spread first, and then the fabric and a further 2 in. of metal. For the first half-section 4x4½-in. scantlings were laid across the roadway at 33-ft. intervals, while the top layer of metal was being spread and the road brought to grade by templet; in the second half-section the scantling was fixed in position while spreading the lower course of metal, the fabric laid and cut at each wood joint and a further layer of 3 in. of 2-in. metal laid.

The grout was 1 cement to $2\frac{1}{2}$ sand, and it was kept in continuous agitation. It was poured through a hose, the grouting beginning from the highest point under construction and from the center of the road out to the edges. The grout was flushed to the surface by rolling with a 2-ton roller, and during rolling $\frac{1}{4}$-in. crushed gravel was spread at the rate of approximately 1 ton per 100 sq.yd. It was then found necessary to follow the rolling, first with a light templet off the side boards to level off inequalities, and then with a heavier templet tamper, the whole being finished with a belt. Curing was effected by spraying at the rate of $\frac{1}{4}$ gal. per square yard of emulsion within 48 hours of the grouting, while sand was spread as the separation of the bitumen from the emulsion took place.

Rubber bitumen mixture

The Queensland main roads commission has recently experimented with a type of construction, which, so far as is known, has not been employed in any other part of the world on anything like an extensive scale.

Certain small-scale laboratory experiments were made to obtain information on the solution of rubber in bitumen. From these experiments the following conclusions were drawn:

1. A homogeneous mixture of rubber (motor tire tubing) and 60/70 bitumen can be obtained.
2. Adding the cold rubber to the hot bitumen is the best method of obtaining the mixture.
3. The higher the temperature of the hot bitumen the less time is required for the rubber to dissolve.
4. Within the temperature range of 300 to 350 deg. F. it takes in the vicinity of two hours for the rubber to dissolve by heat alone.
5. Stirring the hot mixture is dangerous, as excessive frothing is likely to occur.
6. The resulting mixture gets softer and more sticky with increasing rubber content.
7. With 20 per cent rubber the mixture has a consistency similar to freshly made putty.
8. With from 0 to 10 per cent rubber the mixture has marked elasticity, the less rubber the harder the mixture.
9. Ductility decreases with increasing rubber content.

With these data available, some experimental sections were put down to get a working knowledge of the penetration qualities of the mixture—to see if it gave better binding and cushioning than the ordinary bitumen, to ascertain the surface effect as regards skidding and to obtain data as to whether the mixture of rubber gave more stability and a longer life than bitumen alone. The job was treated as an ordinary penetration job, except where the rubber mixture was utilized.

It was noted that on the penetration and seal coats for a 5 per cent rubber mixture a big variation in the time the rubber took to dissolve existed. In the case of a 10 per cent mixture a difference of 23 hours was noted. Although extreme cases exist, especially with the 5 per cent solutions, the penetration values on the average get higher with increases in rubber content. This may be seen from the following tabulation:

Per Cent Rubber	Average Penetration at 77 Deg. F.
0	62.66
2½	69.00
5	70.22
10	81.00

At the finish of the job the officer in charge made the following comments:

In future work it would be advisable to get an evenly graded rubber, such as 20x5 rubber tubes or thereabouts, these being the most commonly used sizes. Heavy tubes are not advisable, because the extra thickness of the tubes accounts for many hours of extra boiling, thereby destroying both the properties of bitumen and rubber.

The only practical way to dissolve the rubber in a reasonable time is to chop it up finely into strips about $\frac{1}{4}$ to $\frac{1}{2}$ in. wide and mix with enough bitumen to cover the rubber, push the heat up to at least 480 deg. F. and maintain this for a period of from two to three hours, when the rubber will dissolve. At this stage the balance of the bitumen, which has been steadily heating and maintained at a steady heat of from 300 to 350 deg. F. for 1½ hours, should be added.

Heated about 400 deg F., the mixtures give inflammable fumes, and it is therefore extremely risky to attempt to dissolve any large quantities of rubber and bitumen at this heat; at 300 to 350 deg. F. the mixture does not appear to change much after about 10 hours' boiling.

The job was completed on April 4, 1930. The result to date is satisfactory, an excellent surface being maintained. There are no indications of cracks or any sign of bleeding, but it must be remembered that the road at the time of writing had not been subjected to hot weather to any extent. It is apparent, however, that the addition of the rubber has given increased stability to the bitumen and has made it more tenacious than the ordinary bitumen. By lifting the pavement with a pick it was seen that about two to three times the area was affected than would be with bitumen alone.

It is too early yet to make any comments on its cushioning or elastic properties; but simple laboratory experiments indicate that the anticipated elasticity of the mixture will not be realized. This factor has not yet been fully investigated, as it is thought that the extremely high temperature necessary to dissolve the rubber has deprived it to some extent of its elasticity. This is now in hand. The section carries a daily average of 643 vehicles every twelve hours.

Bituminous macadam

Bituminous-macadam penetration construction has afforded plenty of scope for experiment, and as a result sealing the work immediately is adopted almost universally. By this method covering with gravel or screenings in the summer, which is one of the chief items of maintenance on a road sealed with bitumen or tar, will be avoided, as the incorporation of the mineral matter in the seal coat is continued during the whole of the period of backrolling for the complete consolidation of the bituminous macadam.

In some cases, instead of sealing in the usual way with a sprayed coat of bitumen, a seal coat consisting of a thin coating of sheet asphalt has been laid on the unsealed bituminous macadam. The sand, filler and bitumen were heated and premixed in the required proportions at a central mixing plant, spread upon the bituminous macadam surfacing at the rate of 50 lb. per square yard and consolidated by rolling.

The quantity of asphalt applied, which is equivalent to approximately ½ in. of consolidated asphalt if the material were laid upon a perfectly true surface, gives a minimum cover of approximately ⅜ in. over the high points of the bituminous surfacing, the remaining material filling the voids in the surface and being used to take out any irregularities.

Filler is added at the rate of 5 per cent of the total dry mix; and the quantity of bitumen, which is of 40-50 penetration, varies between 9 and 10 per cent. The grading of the sand specified is given below:

Sieve	Percentage Passing Sieve and Held	
1-2	Minimum	Maximum
10-40	15	40
40-80	30	55
80-400	15	40

Of the actual mix the maximum quantity passing a 40-mesh sieve and held on an 80-mesh sieve has been sometimes exceeded. As the coat has been very thin, this was not considered serious.

Surface applications

Apart from the sealing and resealing of waterbound bituminous macadam and gravel roads, successful experimental lengths of spraying have been carried out on gravel and on sandy-loam formations. On these experimental sections the priming coat consisted of a 50-50 mixture of fuel oil and 85-100 penetration bitumen, while the seal coat consisted of 60-70 penetration bitumen. As the work is carried out by hand, the rate of application is 0.3 gal. for both primer and seal coats.

On one section a sand-clay road has been primed with distilled tar and with a 50-50 mixture of fuel oil and bitumen, the seal coat in both cases consisting of 60-70 penetration bitumen. On another section ¾-in. granite screenings were used as mineral aggregate. The priming coat consisted of a 50-50 mixture of fuel oil and bitumen, while the seal coat was 0.24 gal. per square yard. A cubic yard of ¾-in. screening covered 109 sq.yd. of road surface.

Mixed-in-place surfacing

A considerable advance has been made also in the treatment of gravel roads with bituminous road oil, mixed *in situ* in lieu of the ordinary road oil. The successful treatment of gravel roads in this manner is of immense importance to Australian road authorities, because of the great length of such roads that necessarily must exist in a large country like Australia, where road construction is generally in the development stage. Best results were obtained from bitumen fluxed with a crude oil to give a 70 per cent bitumen content of 80-90 penetration. Because of the wide use that is likely to be made of this form of construction in the future, it is of interest to note the methods adopted.

Upon a previously prepared metal bed a top course of gravel is spread to a required width on each side of the center line of the road, and at a uniform rate of a given number of cubic yards per 100 lin.ft. When the existing gravel pavement is of a satisfactory quality and of sufficient thickness without the addition of extra gravel, the top 3 in. is scarified and thoroughly harrowed to break up all the lumps and obtain an even grading of the gravel. The gravel, whether newly spread or in the existing formation, should be of hard non-absorbent stone, free from earth, clay or vegetable matter. It should contain no stones larger than 1½ in., and not more than 5 per cent should be retained on a screen with 1-in. circular openings. It should be well graded from 1 in. down to dust and should contain not more than 35 per cent of stone and fines passing a ½-in. screen. Upon this well-scarified top layer of gravel a liquid or fluxed bitumen is sprayed uniformly at the rate of 1 gal. per square yard. Special care should be taken to obtain an even application of the bitumen, which should be applied in two coats, each at the rate of ½ gal. per square yard. After each coat has been applied, the gravel should be well harrowed with disk cultivators and spring-toothed harrows, so as to remove the excessive stickiness of the oil. The engineer may vary the quantity of fluxed bitumen to suit the particular grading of the gravel being used.

Where no side track is provided, the spraying or pouring of the bitumen and mixing should be done on half the width of the road at one time. After mixing, traffic may be allowed to use the road.

On the completion of the spraying or pouring and harrowing of each coat, the partly mixed material should be gathered into windows, preferably by a power grader, and moved from side to side of the road until complete mixing has been obtained and the color is uniform. Great care should be taken to avoid getting any of the earth flanks into the mixture, and none of the mixture should be allowed to be turned upon the flanks.

After complete mixing has been obtained, the mixture should be graded to a uniform depth over the full width of the road. The flanking material should be spread, and the whole should be consolidated by means of a 5- to 6-ton roller giving one to two hours' rolling for each 100 lin.ft. of roadway.

If patching is done, care must be taken to avoid the use of excess bitumen. Re-oiling should be done sparingly and only where there is clearly a deficiency in the bitumen. The fluxed bitumen used in this work should consist of a mixture of 65 per cent of bitumen, having a penetration of 80 at 77 deg. F. and 35 per cent of fuel oil. The fuel oil should be poured into the bitumen before the latter has reached a temperature of 125 deg., and the mixture should be constantly stirred under a slow heating until thorough mixing has been obtained. It is dangerous to pour fuel oil into bitumen at a higher temperature than that stated.

The fluxed bitumen should be applied at a temperature between 250 and 300 deg. F., and it should be used within 20 min. of reaching that temperature. The mixing should be done only in dry weather when the gravel is thoroughly dry, and preferably in warm weather.

High Compressive Strengths for Stone

An examination of the test records of the Bureau of Standards shows the following extreme values for compressive strength of various stones:

	Lb. Per Sq.In.
Quartzite from Montana	63,000
Marble from Vermont	50,000
Novaculite from Arkansas	44,000
Granite from Maryland	42,000
Limestone from Tennessee	40,000
Sandstone from Wisconsin	29,000

Even the highest of these is somewhat lower than a test made some time ago in Germany on basalt, which gave 67,000 lb. per sq.in. In general, it may be said that the values given above are from two to four times the average strength of the various types named, except for novaculite, which is probably not far from the average.

Cool-Room Cement Testing Necessary at Arizona Highway Laboratory

By J. W. Powers
Engineer of Materials, Arizona Highway Department, Phoenix, Ariz.

SUMMER TEMPERATURES produce testing-laboratory conditions that have necessitated the providing of an artificially cooled cement-testing room at the Arizona highway department laboratory at Phoenix. The problem of complying with A.S.T.M. specifications for temperature control has been satisfactorily met and maintained in a small insulated room cooled by refrigerating coils operated by a 1-hp. compressor. Automatic control maintains the temperature near 70 deg., thus solving this peculiar problem.

A study of room-temperature variations expected in the laboratory showed that the control problem to meet standard specifications was exclusively one of cooling. No recommendations are made by the A.S.T.M. concerning the kind of equipment to be used. A questionnaire to other laboratories indicated a surprising lack of uniformity in equipment and methods used to secure the required temperature control for cement-testing rooms. From a consideration of the answers to the questionnaire the following method was evolved for cooling and maintaining the temperature of the room, moist closet and storage tank.

A room 9x14 ft. and 8 ft. high was constructed of hollow gypsum tile plastered inside and out, the concrete floor of the basement and concrete floor above being used for floor and ceiling, respectively. Near the ceiling and along one side, extending almost one-third the width of the room, is a metal faced baffle. Above this baffle plate are the two cooling coils. These coils are cooled by a 1-hp. water-cooled compressor controlled by a mercoid switch inside the room. The baffle is built in the shape of an L and tilted to one side, causing sufficient convection currents to maintain a uniform temperature within 2 deg. of 70 deg. F. The localizing of the cold spot near the coils is not enough to disturb the desired even temperature of the working and storage space in the room. Provision was made for ventilation by a small window near the rear of the room, but this has not been used, as one man working in the room has experienced no inconvenience.

The moist closet is built of soapstone with two solid soapstone doors, each 2 ft. wide, closed with refrigeration fastenings. Its outside dimensions are 4 ft. 4 in. wide by 3 ft. high and 2 ft. deep, providing a maximum capacity of 32 sets of briquette molds. Room for 2x4-in. test cylinders is made by removing every other shelf to provide ample headroom for such test specimens. Humidity is maintained by water spraying against an onyx knob inside the moist closet but kept from actual contact with the specimens. This arrangement maintains a relative humidity of about 98 per cent. All excess water flows from the catchbasin in the bottom of the moist closet into the storage tank and from there into the sewer. The moist closet, being inside the cooled workroom, does not have any provision for either cooling or insulation. Temperature of the water for the spray is maintained at 70 deg. by a smaller water-cooled compressor. A sink with faucet attached to the line supplying the moisture closet furnishes water at 70 deg. F. for mixing purposes. With this set-up the requirements for temperature control have been successfully met for cement and mortar testing.

Letters to the Editor

Engineers Need Licenses in Own Interest

Sir—I am writing to call the attention of your readers, in their own interest, to the desirability of prompt enrollment under the existing state laws for the registration of professional engineers. Either through lack of information or through procrastination, a considerable number of qualified engineers in the registration states have not yet availed themselves of the opportunity to enroll, and such neglect to register is increasingly liable to prove a source of embarrassment to the individual. I believe that these engineers would take prompt steps to correct the oversight if they knew the facts, as given below:

1. Engineers' registration laws are now in force in 28 states, in which are located over 80 per cent of the engineers of this country.

2. Over 35,000 professional engineers have already been registered in these states, including 10,000 in New York and 6,000 in California.

3. The machinery of enforcement has already been put into effect, and men have been arrested, tried and fined for practicing engineering without a license.

4. The civil courts have established a significant precedent in repeatedly dismissing actions for collection of engineering fees when such actions were brought by men who were not registered as professional engineers.

5. The courts have ruled that a contract for engineering services is invalid if the party undertaking to furnish such services is not registered.

6. The courts have repeatedly disqualified experts offering engineering testimony when such experts were found to be unregistered.

7. In one significant case, a man was convicted of second-degree manslaughter for the collapse of a structure which he had designed without a license to practice engineering.

8. The machinery of revocation has already been put into effect, and licenses have been revoked on proof of incompetence, misrepresentation or unprofessional conduct.

9. Actions have been started against individuals misappropriating the designation "engineer" without a license.

10. Public officials are progressively taking a keener interest in the enforcement of the engineer's registration laws.

11. The qualification requirements for registration are being progressively rasied in the various states, and the state boards are raising their standards, so that the securing of registration is becoming progressively more difficult.

12. Admission under the "grandfather clause," on the basis of established practice prior to the enactment of the registration law, is subject to a time limitation by statute or by common law.

13. Although machinery is being developed and improved to facilitate interstate registration for engineers practicing beyond their own state, the qualification requirements for such interstate registration are being progressively raised.

14. Present statutes authorize state boards to consider grade of membership in the national engineering societies in appraising qualifications for registration.

15. State and municipal civil-service commissions have established the requirement that applicants be registered as professional engineers before admitting them to examinations or appointments for the higher engineering positions.

16. Many engineers have found themselves in emergency situations where they would have given a great deal to be registered, when civil appointments, professional engagements or legal actions were involved.

17. In times of economic stress the state boards are swamped with urgent appeals for expedited registration from men who neglected to make more timely application, and such appeals cannot generally be accommodated.

18. An engineer who neglects to reg-

ister because his work at the time is exempt under the law may find himself embarrassed when he faces a change of work or connections.

I believe you will be performing a real service to your readers if you will place these facts before them and call their attention to the advisability of taking the earliest opportunity to enroll under the registration laws. I have personally suggested to state officials that they defer any general enforcement campaign until opportunity is given the leading engineering publications and the national engineering societies to cooperate in this manner.

D. B. STEINMAN,
President, National Council of State Boards of Engineering Examiners.
New York, N. Y.,
Feb. 18, 1932.

Use Cement-Water Ratio Judiciously

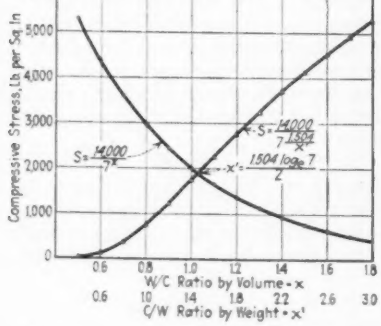
Sir—The article by Professor Lyse dealing with the use of the cement-water ratio for use in designing concrete (*ENR*, Nov. 5, 1931, p. 723) is very interesting and the idea presented is quite unique. New ideas are always to be sought after and are, as in this case, of material value. In commenting on the proposed method I wish to show how some data I have obtained conform to Mr. Lyse's cement-water ratio and to discuss the method briefly.

Some time ago a series of tests was carried out, using mixes varying from a 1:1½:3 to a 1:3:6 by dry-rodded volumes, and varying the consistency, using three slumps. For each condition specimens were made with and without Celite as an admixture, at the rate of 15 lb. per cubic yard of concrete. In plotting the data and arriving at a w/c curve that appeared to fit the data, it was found that the mix as well as the amount of water apparently had an effect on the strength obtained, and there appeared to be a separate relation as regards strength, cement and water for each mix. The richer mixes were influenced more by an increase in water than the leaner mixes, and higher strengths for a given w/c ratio were obtained with the lean mixes. I may say that the condition, as regards the apparent effect of the mix, can hardly be considered accidental because the 90-day strengths showed the same tendencies, and similar data published in the A.C.I. *Journal*, January 1931, p. 432, indicate similar divergence from the w/c strength relation. My first thought in applying the new method to the data shown was that the effect of the mix might be compensated for. However, it was found that this was not accomplished and that the data did not conform so closely to a straight line when using the c/w ratio as they did to the w/c ratio curve. Though the differences were not overly large, they were fairly definite. Being inquisitive, as most of us are, I worked out the curve $S = 14{,}000/7^{x}$ and then plotted the strengths against the c/w by weight ratios corresponding to the w/c by volume ratios. These two curves are shown in the accompanying illustration. If we premise that the w/c strength relation gives the correct strength for a given quantity of cement and water, it will be found that the corresponding curve using c/w ratios as abscissas will be given by the equation

$$S = \frac{A}{B^{\frac{1.504}{x'}}}$$

where x' is the weight ratio c/w. Factors A and B are identical for both curves. It will be noted that the c/w curve is concave downward from a point of inflection that occurs at $x' = \frac{1.504}{2} \log_e B$, or in this case $x' = 1.463$, corresponding to w/c or $x = 1.028$. The fact that this is a curved line makes the proposed method an approximation if the premise above given regarding the w/c ratio is correct. For example, suppose two strengths are available at c/w ratios of 3.0 and 1.0, correspondng to w/c ratios of 0.5 and 1.5, a strength of 3,000 lb. by the straight-line method should be about 8 per cent greater.

Should we not be interested in a condition patently in error by a possible 8 per cent? There have been occasions when materials recommended as admixtures for concrete have been adversely criticised because of apparent reductions in strength only a fraction of this amount. It has been shown and generally is reasonably near true that, within certain limits and for given conditions, the strength varies according to some w/c ratio law. However, this itself is an approximation, and various relations must be determined for varying conditions. Though I do not wish to criticise, it is my belief that to use or adopt an approximation of a method that in itself does not represent an exact condition is really a step in the wrong direction.



Assuming that w/c ratio give correct strength, replatting of data on the basis of c/w ratios does not result in a straight line, but a curved line giving strengths about 8 per cent higher than a straight line.

If it is simplicity from the use of straight lines that is desired, I would point out that if the logarithms of the strengths are plotted against the w/c ratio, a straight line results between those points. On the other hand, if a correct c/w strength curve is desired as governed by two strengths and their c/w ratios, the task would be as laborious, even using logarithms, as it is for the w/c ratio without using logarithms.

Where the variations in the c/w ratio are relatively small and the mix is unchanged, or where the cement factor does not vary widely, straight lines, within experimental error, will give a reasonable idea of the effect of varying the quantity of water or cement. This also appears to be the case where the governing factor is the w/c ratio, although the deviation may be greater.

The point made by Professor Lyse that the strength increases with an increasing concentration of the paste (higher c/w ratio) is well taken. Although we have had the thought inculcated along with the w/c ratio theory, it has been like reading type because of the reciprocal relation. By using the c/w relation the influences of greater quantities of cement and smaller amounts of water are more easily visualized. This condition is also parallel with the general relation between density and strength for a given mix in that the strength is greater as the density or the concentration of the paste increases.

My comments relative to the deviation of the c/w strength-line relation from actual conditions have been based principally on relatively wide variations in w/c and c/w, which, however, are not excessive when considering a wide range of conditions. They are therefore not to be considered as critical of Professor Lyse's suggested method when it is confined within reasonable limits. My reaction is that the c/w strength relation will be an expeditious tool for most practical conditions where the variables extend over a relatively narrow range.

GEORGE A. SMITH,
Concrete Research Engineer,
Johns-Manville Corp.
New York, N. Y.,
Jan. 16, 1932.

Economic Hydraulic Gradient for Conduits—A Correction

Sir—In the article "Formula for Economic Hydraulic Gradient for Conduits," written by me and published in your issue of Jan. 21, 1932, there is a typographical error in equation 7. If you will refer to the original text, you will find that the numerator of the exponent has been omitted, and the equation should read as follows:

$$C = a\left[\frac{Q}{bS^{\frac{1}{2}}}\right]^{\frac{3m}{4}}$$

RAYMOND A. HILL.
Los Angeles, Calif.
Feb. 2, 1932.

NEWS OF THE WEEK

San Gabriel Dam Contract Awarded Over Bidder's Protest

THE Merritt-Chapman & Scott Construction Co., of San Pedro, Calif., whose bid on the contract for building Dam No. 2 of the Los Angeles county flood-control project in the west fork of San Gabriel Canyon was nearly $500,000 lower than the next low bid, has been forced by the county board of supervisors to accept the job despite a strong plea to be released on the ground of an error in the figures. Seven bids were received on the contract, advertised for in two proposals. Proposal No. 1 is for a dam with poured concrete facing and No. 2 for one with gunite concrete facing.

Merritt-Chapman & Scott bid $1,686,464 on proposal No. 1 and $1,690,264 on No. 2. The W. E. Callahan Construction Co., the high bidder, bid $2,914,975 on No. 1 and $2,918,975 on No. 2. The county engineers' estimate on No. 1 was $2,912,520 and was $2,917,520 on proposal No. 2. The low bid entered by Merritt-Chapman & Scott was actually $432,196 lower than the second low bid, $1,228,711 below the highest bid and $1,227,265 below the county engineers' estimate.

Following the opening of bids, the supervisors referred them to Chief Engineer E. C. Eaton of the county flood-control district to be analyzed. He reported that the low bidder is financially responsible and recommended award to the low bidder on proposal No. 2.

The board of supervisors voted unanimously to award the contract to Merritt-Chapman & Scott after brief deliberation and following a request from the company that it be permitted to withdraw its bid without prejudice on the ground that an error had been made in figuring the job. The company has fifteen days in which to sign the contract. If it fails to do so, it will forfeit its bidder's bond, amounting to $160,000.

Waterloo Bridge in London to Be Replaced

The famous Waterloo Bridge, spanning the Thames River in London, England, completed by John Rennie in 1817, is, according to news despatches, to be demolished and replaced by a modern structure to be designed by Sir Gilbert Scott. The vote of the London county council to demolish the old bridge and erect a new one followed seven or eight years of controversy as to the adequacy of the old bridge and the desirability of removing such a famous landmark. Waterloo Bridge is a masonry structure consisting of nine elliptical arches of 120-ft. span and 34-ft. rise. Its piers and abutments are founded on timber cribs resting on piling. It is not so stated, but it is possible that the deterioration of the timber supports, as has occurred in other early bridges, has been an important element in the decision to replace the bridge. The new bridge, whose type is apparently not yet determined, will accomodate six lanes of traffic. Sixty per cent of the cost will be borne by the ministry of transport, a national body, and the remainder by the London county council.

Construction Work Stops on Long Island Park System

Through the failure of the New York state legislature to provide funds necessary for the continuation of its work, the Long Island State Park Commission has had to discontinue the greater part of the work which it had under way or projected for the coming year. All work on the Northern State Parkway has been stopped, including not only the extension of the parkway on right-of-way already acquired but also the paving of the first section which has been graded and for which all bridges have been constructed. Appropriations for work on the Southern State Parkway have been cut in half and transferred to the public works department. All survey work in the preparation of plans for the extension of the Grand Central Parkway to connect with the Tri-Borough bridge over Hell Gate and to the Interborough Parkway, and for the extension of the Southern State Parkway to the Brooklyn city line has been discontinued.

The closing down of the construction work will throw out of work the engineering, architectural, landscape and technical staff of the commission, consisting of about 200 men. Further, survey work and land title search work on which it was hoped that about 200 of the unemployed engineers in the metropolitan district could be employed between now and spring will have to be given up.

The commission is now employing between 1,300 and 1,400 men on relief work. Funds for this work will all be expended by March 21.

United States Supreme Court Rules Kincaid Injunction Illegal

Injunction stopping work on Boeuf floodway reversed on basis that complainant has adequate remedy at law for damages suffered

By Paul Wooton
Washington Correspondent

REVERSING the decisions of the U. S. court of appeals for the fifth circuit and of the federal court of the western district of Louisiana in the Kincaid case, the U. S. supreme court held in an opinion handed down on Feb. 23 that the fifth amendment to the Constitution does not require payment in advance for property that may be taken. "As the complainant has a plain, adequate and complete remedy at law," the court ruled, "the judgment is reversed with direction to dismiss the bill without prejudice."

In this decision the court contents itself with the ruling that the lower courts were wrong in granting an injunction. It had been hoped that in rendering this decision the court would interpret the points in the flood-control act which are involved in this case. The decision therefore does not clarify the act.

Policy will not change

Despite the fact that the government has won in this case, the policy of the administration is not expected to change. The President has taken the position that the diversion will not be made until there is evidence that a majority of the people principally concerned want it. There is nothing in the court decision to uphold the Jadwin theory that the basins to the west of the Mississippi owe a servitude to the river. For that reason the government has no assurance as to the amount it would have to pay for flowage and damages. It is not likely to embark upon floodway construction until it knows what it will cost. The only difference the decision makes is that property owners would have to take their cases to the court of claims and possibly might not have a case at all until their lands are actually damaged by additional floodwaters.

Riley J. Wilson, chairman of the flood-control committee of the House of Representatives, has announced that he will call the committee together within the next few days to take up the question "of amending the act so as to make it definite and clear that flowage rights and damages shall be paid before property is taken or works begun which would place the property within the floodway to be used for carrying destructive floodwaters."

Commenting on the decision, Mr. Wilson said that "the court simply holds that the respondent, Kincaid, is not entitled to an injunction to prevent the construction of levees and other works in the Boeuf Basin until the United States will have acquired flowage rights over his land."

Complainant has remedy at law

Most of the text of the decision is made up of a review of the facts in the case. The other portion of the opinion reads as follows:

> We have no occasion to determine any of the controverted issues of fact or any of the propositions of substantive law which have been argued. Kincaid concedes that the act is valid and that it authorizes those intrusted with its execution to take his lands or an easement therein. We may

assume that, as charged, the mere adoption by Congress of a plan of flood control which involves an intentional, additional, occasional flooding of complainant's land constitutes a taking of it—as soon as the government begins to carry out the project authorized. If that which has been done, or is contemplated, does constitute such a taking, the complainant can recover just compensation under the Tucker act in an action at law as upon an implied contract, since the validity of the act and the authority of the defendants are conceded. The compensation which he may obtain in such a proceeding will be the same as that which he might have been awarded had the defendants instituted the condemnation proceedings which it is contended the statute requires. Nor is it material to inquire now whether the statute does so require. For even if the defendants are acting illegally under the act in threatening to proceed without first acquiring flowage rights over the complainant's lands, the illegality, on complainant's own contention, is confined to the failure to compensate him for the taking and affords no basis for an injunction if such compensation may be procured in an action at law. The fifth amendment does not entitle him to be paid in advance of the taking.

A footnote on the opinion reads as follows:

Even where the remedy at law is less clear and adequate, where large public interests are concerned and the issuance of an injunction may seriously embarrass the accomplishment of important governmental ends, a court of equity acts with caution and only upon clear showing that its intervention is necessary in order to prevent an irreparable injury.

Largest Elevator Installation to Be in Rockefeller Center

The installation of 76 automatic elevators in the 68-story office building, the largest of the group of structures in the Metropolitan Square development in New York, will represent the largest group of elevators in any single building, according to the Westing house Electric & Mfg. Co., which has been awarded the 2½ million dollar contract. These elevators are planned to handle the 13,000 regular tenants and in addition a transient population of about 30,000 persons daily. Twenty-four of the elevators will operate at a speed of 1,200 ft. per minute, permitting an elevator running express to the 65th floor to cover the whole distance of 805 ft. in about 50 seconds, as against 1 minute 20 seconds under the speed of 700 ft. per minute allowed by the old building code. Operating on a full schedule from 8 in the morning to 6:30 in the evening, the 76 elevators in this building will travel over 21,000 miles a day.

Pennsylvania R.R. Car Ferries for Lake Michigan

As a development of the Pennsylvania R.R. plans for car-ferry service on Lake Michigan (see *ENR*, June 4, 1931, p. 943), the company has applied to the Interstate Commerce Commission for approval of an agreement by which it will become a 75 per cent owner of the Grand Trunk-Pennsylvania Transportation Co., organized to purchase for $2,390,000 the four car-ferry steamers of the Grand Trunk R.R. This latter line now operates its car-ferry service between Grand Haven, Mich., and Milwaukee, but has been authorized to operate from Muskegon, Mich., where it is building a ferry landing. The Pennsylvania has a line into Muskegon and the new company proposes to operate steamers from Muskegon to Milwaukee and Manitowoc, Wis.

Hoover Dam Notes

The flood which stopped work Feb. 9 on the diversion and inclined spillway tunnels of Hoover Dam came out of the Virgin River. At Black Canyon a stage of 656.5 was reached Feb. 10. The river started to rise Feb. 9. It rose 11 ft. during the following 24 hours. The flow increased from 5,000 sec.-ft. to approximately 35,000 sec.-ft. A second flood arrived Feb. 12 which rose 5 ft. higher than the peak of the previous flood. The principal damage was the washing out of a temporary bridge which was used at the upper portals to haul muck from the Arizona tunnels. Work in the tunnels was resumed Feb. 17.

* * *

The unusually heavy snowstorm in the northern part of Nevada and the rains in the southern part of the state were responsible for the unusual volume of water in the river and for much damage to railroads and highways. The bridge across the Virgin River on U. S. Highway No. 91 between Las Vegas and Cedar City was washed out.

* * *

Excavation was started on the Nevada spillway on Feb. 10. During the week ended Feb. 13 only 160 ft. of work was done on the diversion inclined spillway tunnels on account of high water.

* * *

Work on the Boulder City theater began Feb. 9. The Nevada Construction Co., of Las Vegas, was the successful bidder for the work. It is to be completed in May. The filtration plan has been completed. The sewage-disposal plant is ready for testing. The overhead lines for Boulder City's electric system are 80 per cent installed. Most of the lamp standards are in place and 65 per cent of the overhead lights have been hung.

* * *

The problem of caring for the unemployed in Las Vegas continues. Large numbers of persons are attracted there in the hope of getting work on the dam. Because of the cold weather the needs of the unemployed are greater and local facilities are being taxed to the utmost to take care of them.

* * *

Dr. J. H. Talbott, of the Harvard University Fatigue Laboratory, is making investigations of temperature records and procuring data preliminary to a study of the effects of summer temperatures upon workers at the Hoover Dam.

* * *

A fatal accident occurred Feb. 8, when a shovel mechanic was crushed between the counterbalance and the wall of tunnel No. 2.

* * *

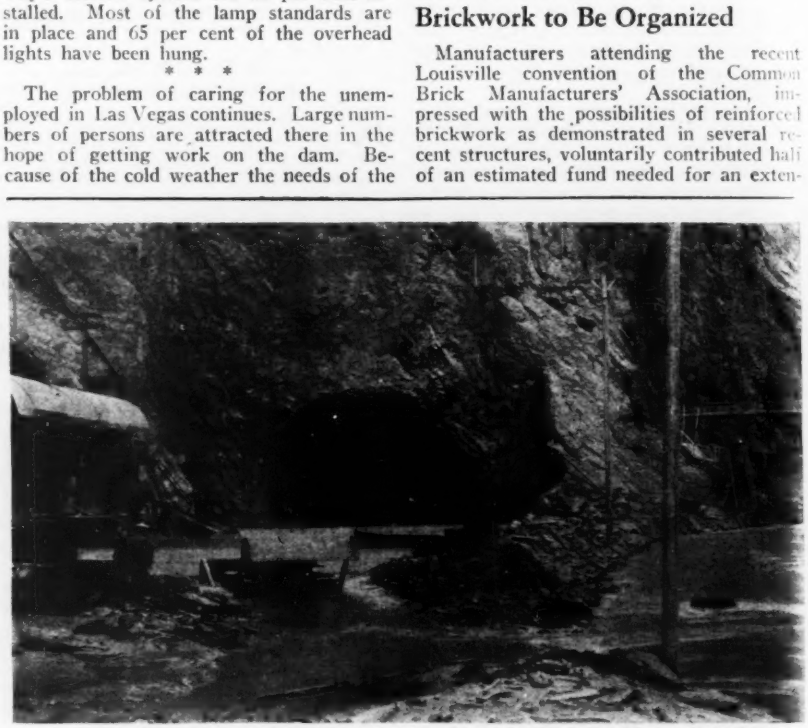
A bus line has been organized to furnish common carrier service between Kingman, Ariz., and Boulder City.

Bermuda's Waterworks System Formally Opened

The waterworks system of Bermuda was formally opened on Feb. 11. The residents of Bermuda are dependent upon rainfall for their fresh water and at times there have been serious shortages because not all the rainfall could be saved and stored. The new system, which was planned and constructed by Prof. W. D. Turner, of the department of chemical engineering of Columbia University, and which was described in *ENR*, Oct. 22, 1931, p. 668, is expected to overcome this and supply the residents with fresh water at all times.

Research in Reinforced Brickwork to Be Organized

Manufacturers attending the recent Louisville convention of the Common Brick Manufacturers' Association, impressed with the possibilities of reinforced brickwork as demonstrated in several recent structures, voluntarily contributed half of an estimated fund needed for an exten-



HIGH WATER STOPS WORK AT HOOVER DAM FOR FIRST TIME

A flood originating in the Virgin River valley raised the water level in Black Canyon at the site of Hoover Dam to such an extent that three of the four diversion tunnels were flooded, causing a temporary shutdown of the work on Feb. 9. This view shows water flowing from the outlet of one of the tunnels. The bulldozer shown in the illustration is cutting out a channel to drain the tunnel when the river level drops.

sive program of research which is to determine certain construction factors now in question. It is expected that an early canvass of the association membership will insure the completion of this fund, as the manufacturers generally are coming to appreciate the necessity of obtaining authoritative data on the utilization of their product.

In the development of this research program the assistance of the U. S. Bureau of Standards and university testing laboratories will be enlisted, and leading organizations in the construction field will be drawn upon for members of the advisory committee. The scope of the investigation will be such as to develop all possibilities of the new type of construction and the methods necessary to make certain the best results.

Northeastern Highway Officials Hold Annual Meeting at Atlantic City

A SERIES of unusually interesting papers on live highway topics featured the eighth annual convention of the Association of Highway Officials of the North Atlantic States held at Atlantic City Feb. 17-19. Nearly 700 were registered at the meeting, and all sessions were well attended. Local and secondary road administration and financing, bituminous road construction, control and testing of concrete aggregates, and fills across swamps were some of the subjects receiving attention. According to several papers and resulting discussions, the road-mix and plant-mix bituminous types widely used in the West are now finding favor in the Northeastern states.

In the establishment of a road service for communities not on the state highway system, Thomas H. MacDonald, chief of the U. S. Bureau of Public Roads, emphasized the necessity for engineering statesmanship in planning financial and administrative policies. He stated that ever since the first state highway department was established there has been fairly consistent progress toward better rural highway administration—better in respect to standards of design and workmanship, in economy of expenditures and in meeting statewide traffic service needs, but that this growth has not been sufficiently rapid for the critical time which has now come upon us. We are faced with a difficult fiscal situation with the unequivocal demand for no decrease in either the quality or the extension of highway service. We are confronted with an acute reaction against taxation, particularly of real property.

There are many demands, Mr. MacDonald said, to divert the income from special taxes upon the road user to other governmental purposes — demands that would be much more pronounced were more state legislatures meeting this year. It is probable that next year there will be more vigorous attempts to divert this income to other uses than for roads and from the control of the state highway departments. This would be a much more serious blunder than the spreading of these special taxes to roads other than the state highway systems. According to reports of the bureau representatives and state highway officials throughout the country, the states are divided into three classes financially, with corresponding degrees of possible aid to rural extensions: (1) States, without exception, which have placed the administration of income from special taxes (gas tax and license fees) wholly under the control of the state highway departments are in the best condition financially to carry forward their state programs and to extend assistance beyond the roads included within the state systems. (2) States not retaining within the state highway departments direct expenditures of all incomes from special road taxes but still providing a general control of the expenditures of the part of the income allotted to other governmental divisions are without exception able to meet their obligations for state roads and through this definite direction are obtaining the coordination of state and local road improvement. (3) States which have divided the control of special road tax funds between the highway department and other agencies are for the most part facing serious financial difficulties, on the part of both the state and localities, to maintain existing roads and to go forward with a greatly reduced program.

Mr. MacDonald advocated taking over all highways by the state departments in those states having a small area or in which the county or town government is essentially rural in character. In states of large area and in which county government has been well developed, and which contain metropolitan areas, this should not be done, but the county and metropolitan areas should be made the smallest areas of administrative units. In any event, the only hope for the taxation situation is a thorough revision of our system of local road administration in so far as the strictly rural townships are counties are concerned. Property taxation for rural road purposes cannot be replaced entirely by special road taxes, but proper engineering administration will prevent the waste and inefficiency now prevalent in local road administrations.

Feeder roads

Development of feeder roads in their respective states were described by Lucius D. Barrows, chief engineer, Maine state highway commission, and by A. W. Bushell, engineer on contracts and construction, Connecticut state highway commission. In Maine the local road development was well along before the state highway department was organized. The state is now building three separate highway systems—a main state system; state-aid highways not included in the state system but connecting principal settlements and acting as feeders to the first system; and a third class separate from the first two systems, containing roads which are designated by municipal authorities for improvement with apportionment from state funds.

A state-aid road system provides the feeders for Connecticut's state highway system of main trunk lines. Annually $1,000,000 is appropriated from the special road taxes for these feeder roads, divided among the 169 towns of the state, with the towns contributing from one-eighth to one-fourth of the cost. These roads are maintained and rebuilt by the state. Last year bills were passed providing for $3,000,000 annually to go to rural roads not on the state highway system. The towns designate the type, route and width of these roads, which are built under state supervision but are thereafter maintained by the towns.

Bituminous materials

The use of tar, emulsified asphalts and cutback asphalts in modern road construction was outlined by George Martin, the Barrett Co.; C. L. McKesson, the American Bitumuls Co.; and Bernard E. Gray, the Asphalt Institute, respectively. Each showed the application of his product to road-mixed and plant-mixed types of new construction and to retread work.

The use of the drag, the retread mixer and the blade grader, together with the development of cutback asphalts, emulsions and retread tars, has revolutionized the art of constructing and maintaining bituminous roads, declared H. E. Sargent, commissioner, Vermont department of highways. He described the new methods of bituminous construction developed in his state whereby the subgrade is thoroughly treated and shaped, the wearing surface of sand and gravel is mixed with bituminous material on the road, after which the surface is carefully sealed with stone chips and a seal coat. The wearing surface is rolled after final spreading.

Swamp fills

Experiences in placing fills across swamps were described by C. L. Wooley, construction engineer, Rhode Island state board of public roads. In the ordinary type of swamp where the soils are light sands, silts and sandy loams, removal of trapped water pockets was found to be the only remedy needed, care being taken to compact the fills over these areas during construction. In muck swamps and tidal marshes blasting has been found effective to obtain fill subsidence. The first step is to break and remove the top mat of roots and underbrush, very effectively done by placing 1-lb. sticks of 60 per cent dynamite 1 ft. below swamp level, spaced 18 in., and fired by propagation. This is all the treatment necessary for swamps less than 6 ft. deep. In areas of muck greater than 6 ft. in depth the filling is started after the top mat is broken, and as every 50-ft. station is reached, three 2½-in. pipes are driven in the face of the fill down to hardpan. These pipes are loaded with dynamite midway between the hardpan and base of fill. When fired the muck moves out and the fill settles into place.

Concrete aggregates

The quality of aggregates entering into highway concrete so affects the durability of the road that in many cases it is to the economic interests of the state to ship good aggregates into a section rather than use cheaper but less suitable materials, stated E. C. Lawton, construction deputy, New York state department of public works. Furthermore, Mr. Lawton said, we must realize that character of aggregates and not strength of concrete determines the durability and life of concrete pavements. New York State is keeping service records on many stretches of concrete roads to ascertain the suitability of various aggregates. Aggregates known to be good are being shipped into some sections for incorporating into test roads wherein both

the local and imported materials are used in concrete placed and maintained under comparable climatic, subgrade and traffic conditions. Somewhat over a year ago New York adopted two general tests for sands—one, the sodium sulphate test, which determines the percentage of breakdown as a percentage of the whole sample, the second, a rational chemical test, which determines the percentages of kaolin, feldspar, quartz, calcium carbonates, magnesium carbonates and oxides. Recently the state laboratories have developed a magnesium sulphate test believed to be superior to the sodium sulphate method of accelerated salts testing.

Current trends in the control of concrete aggregates and new batching and mixing equipment are producing uniform concrete of higher quality than ever before produced, stated H. D. Robbins, construction engineer, New Jersey highway commission.

Highway safety will never be realized until uniform traffic regulations are adopted, first by the several states and then nationally, is the opinion of J. A. Williams, of the New Jersey highway commission.

The use of mud jacks in raising sunken pavement slabs in New York State was described by David Noonan, maintenance deputy commissioner of the public works department. Best results were obtained by drilling holes 18 in. from the edge of the slab, spaced 4 to 6 ft., through which a mixture of mud and cement was pumped. In some cases slabs were raised as much as 2 ft. It is important that the shoulders be built up ahead of the jacking process to keep the mud from blowing out at the edges.

Engineer Unemployment Relief Plans Make Progress in Several Cities

PLANS for the relief of unemployment among engineers which have been developing in several of the larger centers of population and which already have brought good results in some centers, notably in New York, are bringing good results in other centers. Progress in New York has been reported frequently in these pages; progress up to Feb. 15 was reported last week.

Boston raises relief fund

Early in January the engineering societies of Boston, in cooperation with the Boston Society of Architects, organized the Emergency Planning and Research Bureau and began the collection of an engineers' fund for relief purposes. Thirteen engineering organizations, including local sections of national societies, are represented. Up to Feb. 18 pledges had been received from 2,243 individuals, many of whom were not members of the engineering societies. The contributions amount to $71,480. There are 104 engineers and architects employed on 25 projects with immediate prospect of starting some rather wide engineering investigations requiring the services of more engineers and architects.

The bureau has opened a drafting room where employment is provided on city-planning and housing studies, on property-depreciation surveys and similar studies of a non-competitive nature. The general rate of pay is $15 a week for five days' work, with chief draftsmen and squad captains paid not over $25 a week.

Baltimore plans relief

The engineering and other technical societies of Baltimore and Maryland have organized an emergency relief committee to find employment for technical men. The work of the body will not be confined to placing members of the various groups but will extend to include all who are qualified by experience or training to become members.

Those joining in the movement include the local sections of four Founder societies and of the American Chemical Society, the American Society for Steel Treating, the American Institute of Architects, and the Illuminating Engineers Society, also the Maryland Association of Engineers and the Engineers Club of Baltimore.

Wilson T. Ballard has been made chairman of the committee and S. L. Thomsen has been named manager.

The new organization has adopted the name of the Engineering Relief Committee of the Technical Societies in Maryland.

Cincinnati firms pledge work

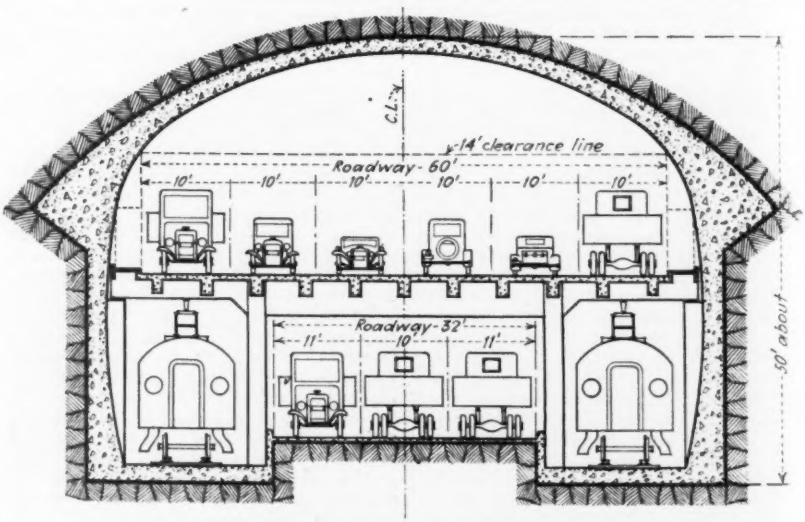
Seventy engineers in Cincinnati, many of them unemployed, have helped the Engineers Committee on Employment make a survey of 400 factories and industrial plants. Upon permission a complete survey of the buildings and equipment was made to learn what work might be done advantageously at once. The engineers then obtained pledges for the amount of work which will be done in the near future. Thus far the engineers have obtained $254,000 worth of work which is being or soon will be carried out. The architect and contractors of Cincinnati are making similar surveys. The work for the engineers is under the direction of Bruce E. Mahan, president of the Engineers Club of Cincinnati.

A day's pay given at Denver

The Colorado Engineering Council has charge of a movement to care for unemployed engineers which is financed by those having work contributing one day's pay per month. To avoid criticism of the $3 paid the engineers employed, only such work as would not be done otherwise is carried on. The work includes such jobs as a survey for straightening sections of the Platte River, a survey definitely locating the old City Ditch and High Line Canal and preliminary surveys for flood control of Cherry Creek. Needy engineers of one year's residence in Colorado are given ten days' work, after which they are replaced by other waiting engineers. A. K. Vickery, D. D. Gross and J. E. Field have supervision of the work. The Colorado Society of Engineers started the movement and is cooperating. About 75 per cent of the unemployed qualified to receive relief have been aided.

Chicago Plans Discharge of Employees

Wholesale discharge of Chicago city employees, 2,500 now and probably 2,500 later, is imminent as a result of the adjournment of the special session of the state legislature without passing relief bills. This drastic action has been recommended to the city council by the mayor as an absolute necessity under present circumstances. An alternative of furlough instead of actual discharge has been suggested. Attempts to secure additional loans have been unsuccessful. The city is now sending out



DOUBLE-DECK TUNNEL FOR TRANS-BAY BRIDGE PROJECT

Crews are now engaged in making borings on Yerba Buena Island to investigate badly faulted and broken rock through which a highway tunnel of unprecedented size is planned as a part of the new bridge project that will connect San Francisco with Oakland. The tunnel as planned will be a two-deck structure 500 ft. long, 70 ft. wide and 50 ft. high, unprecedented cross-sectional dimensions for a highway tunnel. The upper deck will provide six lanes for fast motor traffic, while the lower deck will accommodate three lanes for trucks and slow-moving vehicles and two interurban tracks. Yerba Buena (Goat) Island will be connected to the San Francisco shore on the west and the Oakland shore on the east by bridges—studies for which are actively under way.

its 1930 tax bills, which have been delayed on account of doubt as to their validity, the previous tax bills of 1928 and 1929 being held invalid under Judge Jarecki's decision that the methods of assessment were faulty or illegal. This decision has been referred to the state supreme court, which has not yet acted upon it. Under the law, payments made now may apply upon future revision of the tax bills, so that the city is appealing for prompt payment in whole or in part and is also starting to proceed against so-called taxdodgers.

Charlotte, N. C., Tries Novel Plan to Stimulate Construction

Building and building material contractors and architects of Charlotte, N. C., have started a cooperative movement to give a 20 per cent discount on all prices in connection with building construction. The offer, made in an effort to stimulate construction, will be in effect until March 15.

The plan was announced by the Charlotte unemployment committee after several weeks of conferences. Practically every construction company, general contractor, building supply dealer, plumbing and heating concern, painting contractor and architect has agreed to the plan, according to the announcement. The plan involves furnishing supplies and materials at wholesale cost, and architects and engineers will cut their fees accordingly.

Little Technical Unemployment Found in Milwaukee

Unemployment among Milwaukee engineers of all kinds is not so serious as it was thought to be, says C. S. Stewart, a representative of the Engineers Society of Milwaukee, after making a survey of the situation. Only 30 unemployed engineers have been registered. In most cases employers having small forces have kept these intact on at least part time. Only occasionally are new men taken on.

COSTS AND CONTRACTS

ENR Index Numbers

Cost			Volume	
Feb., 1932	161.82	Jan., 1932		121
Jan., 1932	162.48	Dec., 1931		133
Feb., 1931	196.61	Jan., 1931		208
Average, 1931	181.35	Average, 1931		220
Average, 1930	202.85	Average, 1930		260
1913	100.00	1913		100

This Week's Contracts

Heavy construction contracts, reported by *Engineering News-Record* in the week of Feb. 25, with some comparisons, total as follows:

(In Thousands of Dollars)

	Feb. 25, 1932	Average of Last Four Weeks 1932	1931
Buildings:			
Industrial	$654	$1,605	$3,529
Other	5,635	8,723	16,746
Streets and roads..	3,261	2,650	9,170
Other construction.	11,669	5,971	15,129
Total	$21,219	$18,951	$44,576
Total, all classes, Jan. 1 to Feb. 25:			
1932			$166,675
1931			415,499

Washington Notes

By Paul Wooton
Washington Correspondent

UNDER the stimulus of economy, official Washington is beginning to give serious consideration to long-standing proposals for a more logical and efficient grouping of the government departments. For years it has been realized that many overlapping bureaus could be merged without interfering with their work and that some duplicating services could be eliminated at no great loss. In accordance with general recommendations in his opening message to Congress, the President recently asked Congress for authority to reorganize the government work in his own way. The general opinion on Capitol Hill, however, is that Congress should not extend such broad powers to the executive branch but should do the work itself. Whether or not it would be a good thing or a bad thing to reduce the number of government workers, there is a certain amount of opinion in Congress that believes the problem should be approached directly and not under the guise of departmental efficiency. Meanwhile, various measures are now pending in Congress that would authorize certain specific consolidations. The one that seems to have the greatest support calls for a department of national defense to include the army, the navy and the united air corps. A bill contemplating the department of public works also is receiving favorable consideration. Under the terms of this measure, the engineering and construction activities now carried on by five departments would be brought under unified control.

Departmental Reorganization

Any departmental reorganization that would interfere with the jurisdiction of the Corps of Engineers over the rivers and harbors work and the flood-control work will encounter the active opposition of Senators and Representatives from the Mississippi Valley states. Representative Mansfield, of Texas, chairman of the rivers and harbors committee, has announced that he will vigorously oppose any legislation that may involve the transfer of the rivers and harbors work from the war department to some other agency. Representative Wilson, of Louisiana, chairman of the House flood-control committee, has taken the same position.

Loans to States Suggested

Part of the relief contemplated in a plan recommended by the House labor committee would be made available in the form of $200,000,000 appropriation to expedite work on public building projects. This money would be assigned to projects for which allocations have been made but for which estimates have not been submitted to Congress. Expenditures for professional services would be authorized without regard to any act limiting expenditures for outside professional services. The amount made available in this measure would be in addition to appropriations already made or authorized.

For emergency relief, the bill authorizes loans to the states from a $300,000,000 fund, such loans to be secured by collateral to an equal amount furnished by the states. To aid states that have constitutional prohibitions against applying for loans, the measure provides another appropriation of $200,000,000. Grants from this fund would be made to states by the secretary of the treasury accompanied by a statement that the amount requested is necessary for emergency relief work and cannot be obtained from public or private sources. At the expiration of ten years deductions would be made from appropriations available to the state if the loans have not been repaid by that time.

Convict Labor on Roads

After much controversy, language has been stricken from the agricultural department appropriation bill which would have prevented the use of convicts on federal-aid highway projects. The measure came to the Senate with an amendment prohibiting such use. The Senate appropriations committee decided to drop the amendment. Action on the measure is now pending in the Senate.

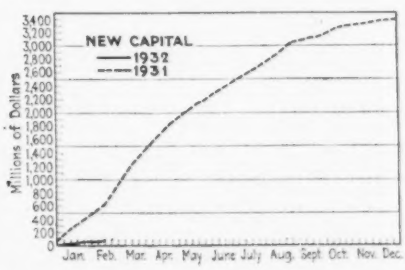
Opposition to the use of convicts on federal-aid highway work was expressed during the committee hearings by representatives of the Associated General Contractors and by spokesmen for organized labor. On the other hand, state highway officials and penitentiary and prison superintendents communicated views in support of convict labor. Somewhere between these two positions, Thomas H. MacDonald, chief of the

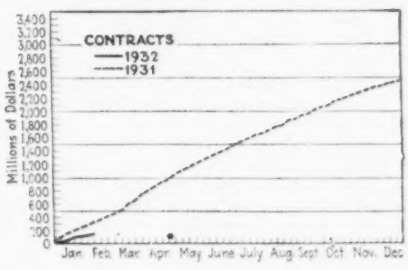
Capital and Contracts

New private capital entered the market in the week of Feb. 20 to the extent of $25,000,000—the first private financing since the week of Jan. 30.

There were no public issues of any kind in the week of Feb. 20, marking the third week thus far this year in which no public bonds were sold. Private issues, on the other hand, have skipped five weeks, since Jan. 1, 1932.

Cumulatively, the total for 1932 stands at $79,000,000, private and public combined, compared with $544,000,000 in the period Jan. 1 to Feb. 21, 1931.





Bureau of Public Roads, took the position that it may be well to bar convict labor during the present period of unemployment but that as a regular procedure this prohibition would not be advisable. Actually, the amount of work done by convicts on federal-aid projects is extremely small, Mr. MacDonald stated. Only four states are involved: Alabama, Virginia, New Jersey and Florida, and as the convicts are used on force-account basis along with free labor, at least half the total expenditure on the job would be for free labor.

No Federal Unemployment Relief

An effort is being made to bring a new relief bill before the House, but it is not likely to succeed because sentiment in the country is changing. The winter is about over. The states and local interests have done their part fairly well considering the hope that constantly was held out to them that the United States might do it. The discussion and the attendant publicity has had the effect of stimulating public thought on the question. Members of the House are beginning to have evidence that a majority of their constituents are opposed to the dispensation of direct aid from Washington.

Calling the proposed $400,000,000 Columbia Basin irrigation project "indefensible," the National Advisory and Legislative Committee on Land Use at Washington Feb. 18 asked for a new policy on federal reclamation. The committee took this action independent of the Land Use Planning committee, which is a committee of government and college administrators and specialists. Both committees were created at the national land utilization conference in Chicago last November, and met last week for the first time. The Bureau of Reclamation should be assisted, the legislative committee agreed, in rehabilitating existing federal projects which may be in distress and in getting these projects on a sound economic basis. No new projects should be undertaken, the committee stated, until the long-time agricultural outlook reveals a necessity for more land in cultivation.

Federal Salary Cuts Not Likely

In the face of a certain veto advocates of cuts in federal salaries have about abandoned their effort. In addition to the reason that this would be a poor example for the federal government to set for private employers, it is apparent that no important saving would result. Exempting clerical workers in all departments who receive $2,000 or less, and members of the army and navy, it is doubtful that an annual reduction of more than $50,000,000 would result from a 10 per cent cut.

May Augment River and Harbor Work

Thought is being given in administration quarters to the substitution of an augmented river and harbor construction program for an emergency appropriation for roads. A study is being made to determine the relative amount of employment that would be furnished per dollar in connection with the two activities. An examination is being made of the contention that highway construction under machine methods does not give as much employment as would a comparable expenditure on river improvements.

Personal Notes

W. S. WATSON, who for sixteen years prior to last May was city water and light commissioner for Hastings, Neb., has been appointed superintendent of the board of public works at Hannibal, Mo. He will have charge of the municipal waterworks and light and power facilities.

EDWARD H. DEETS, associate engineer since 1923 with the C. N. Harrub Engineering Co. and its predecessors, Klyce & Harrub and B. H. Klyce, consulting municipal engineers, of Nashville, Tenn., has been appointed right-of-way examiner in the right-of-way department of the Maryland state roads commission and will have headquarters at Frederick, Md., for a section of the state in that vicinity.

E. VICTOR WILLARD, commissioner of drainage and waters of the State of Minnesota since 1919, has been appointed director of the division of drainage and waters, one of the four divisions in the new state conservation department.

H. A. VAN NORMAN, general manager and chief engineer of the department of water and power of Los Angeles, Calif., on Feb. 18 was presented with a 25-year service pin at a meeting of the board of water and power commissioners.

The General Construction Co., of Seattle, Wash., announces the withdrawal from its firm of J. W. LAWLOR, R. E. WOODWARD and L. P. LAWLOR. J. A. MCEACHERN remains as president and D. V. MCEACHERN as senior vice-president. BEN COOK succeeds J. W. Lawlor as vice-president in charge of all outside work. J. SAMUELSON remains as secretary, and J. E. BEARDSLEY has been elected assistant secretary-treasurer. E. A. WEBSTER remains in charge of all highway construction.

T. S. BRINDLE, of Ashland, Ohio, has been appointed state director of public works, succeeding A. T. Connor, of Zanesville. Mr. Brindle has been in the state highway department for twelve years, at one time serving as chief engineer and more recently as division engineer.

JAY E. JELLICK has been appointed district engineer in charge of the reopened San Francisco office of the Portland Cement Association. Mr. Jellick was formerly in charge of the association office at Los Angeles and later was manager of Pacific Coast offices.

HOWARD F. CLARK, captain, Corps of Engineers, now stationed with the 6th Engineers at Fort Lewis, Wash., has been ordered to report to Washington, D. C., for duty as assistant engineer commissioner.

W. F. HEAVEY, captain, Corps of Engineers, who has been serving in the Panama Canal Zone, has been ordered to Cleveland, Ohio, effective March 1, as assistant to the division engineer of the Great Lakes Division. Capt. Heavey was assistant to the district engineer at Louisville, Ky., from 1922 to 1924.

SOCIETY CALENDAR

AMERICAN CONCRETE INSTITUTE, annual convention, Washington, D. C., March 1-4.

AMERICAN RAILWAY ENGINEERING ASSOCIATION, annual convention, Chicago, March 15-16.

AMERICAN SOCIETY FOR TESTING MATERIALS, annual meeting, Atlantic City, June 20-24.

AMERICAN SOCIETY OF CIVIL ENGINEERS, annual convention, Yellowstone National Park, July, date to be fixed.

AMERICAN WATER WORKS ASSOCIATION, annual convention, Memphis, Tenn., May 2-6.

CONCRETE REINFORCING STEEL INSTITUTE, eighth annual meeting, March 7-9, Atlanta, Ga.

LOUISVILLE CHAPTER, Associated General Contractors, at its annual meeting on Feb. 10 elected M. P. Nicol president, A. J. Ohligshlager vice-president, D. R. Lyman secretary and F. G. B. Metzner treasurer. For the fifth consecutive year the Louisville chapter won the national award for the lowest accident rate on construction work, it was announced.

NATIONAL ASSOCIATION OF RAILROAD TIE PRODUCERS will hold its annual meeting at Memphis, Tenn., May 17-18. The secretary is R. M. Edmonds, St. Louis, Mo.

PACIFIC NORTHWEST SECTION, American Water Works Association, has changed the date of its fifth annual meeting in Wenatchee from May 5-7 to May 12-14 in order not to conflict with the annual convention of the parent body.

WESTERN NEW YORK CHAPTER, American Society of Heating and Ventilating Engineers, has installed M. C. Berman as president, D. J. Mahoney as first vice-president, J. H. Yager as second vice-president, W. F. Johnson as treasurer, and W. E. Voisinet as secretary.

Obituary

BERNARD E. GILPIN, principal assistant city engineer of Phoenix, Ariz., died on Feb. 10 after a brief illness. Mr. Gilpin was directly in charge of the construction of the new Phoenix sewage-disposal plant.

VERNON C. SUCKOW, civil engineer, Seattle, Wash., died in that city on Feb. 12, at the age of 57 years. Mr. Suckow was president of the Engineers Club of Seattle. He was born in Wisconsin, but had been in private practice in Seattle for many years.

THOMAS H. OLDS, valuation engineer for the Midwest Oil Co., died in Denver on Feb. 10, at the age of 49. After his graduation from Cornell University in civil engineering in 1907, Mr. Olds spent several years in Mexico on railroad and power projects. From 1910 to 1914 he represented the Pearson Engineering Co., of London, on Brazilian hydro-electric construction. He had been with the Midwest Oil Co. since 1928. Mr. Olds was a member of the American Society of Civil Engineers, Colorado Society of Engineers, American Petroleum Institute and American Association of Petroleum Geologists.

GEORGE P. TURNER, valuation officer of the Union Pacific System, with headquarters at Omaha, Neb., died suddenly on Jan. 7, at the age of 52. After service in the engineering departments of the Minneapolis & St. Louis Railroad and the Illinois Central Railroad, Mr. Turner went with the Union Pacific Railway in 1909 as an assistant engineer in its engineering department. At the time of the organization of the valuation department in 1917 he was made valuation engineer of the Union Pacific Railroad and in the following year was made valuation officer of the Union Pacific System.

Construction Equipment and Materials

New Camel 5-Yd. Dump Wagon Is Mounted on Tractor

The heavy-duty unit known as the Camel tractor dump wagon, manufactured by the Shunk Manufacturing Co., Bucyrus, Ohio, combines the features of truck, tractor, trailer and bulldozer. The Camel is especially adapted for use in earth-moving operations and excavation in which power shovels or elevating graders are used. The scow design of the 5-yd. body affords clean

New Shunk Camel Tractor Dump Wagon.

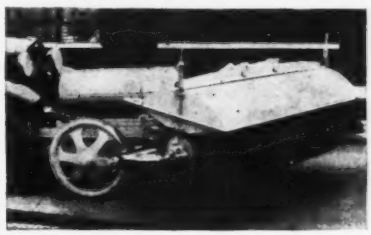
dumping of the load with a minimum of effort. Special rock bodies may be had for quarry work. The nose of the Camel may be converted into a bulldozer. The machine also has a liberal drawbar capacity which is taken off the heavy auxiliary axle. A feature of the machine is that all models are adaptable to interchangeability of wheel equipment. Crawlers, steel wheels or pneumatic tires may be mounted in the field.

Hydraulic Hoist for Snow Plows

A hydraulic pump and hoist unit for both wing and front truck-mounted snow plows is a new product of the Willett Mfg. Co., Grand Rapids, Mich. Controlled from the cab, the unit raises and lowers the heaviest plows in a few seconds. The controls are simple enough to permit the truck driver alone to operate the entire unit easily and without trouble. Pumps for supplying the hydraulic pressure are driven by the power take-off on the truck.

Street Sweeper for Light Trucks

The Willett Mfg. Co., Grand Rapids, Mich., has recently placed on the market a new road and street sweeper for attaching to trucks of about 1½ tons capacity. Power for operating the sweeper is taken off from the front end of the truck motor, and once the installation is made, the entire sweeper can be either disconnected or reattached in fifteen minutes. Steering of the sweeper wheels is controlled by the steering wheel of the truck, and is properly synchronized therewith. Controls for the operation of the sweeper are conveniently

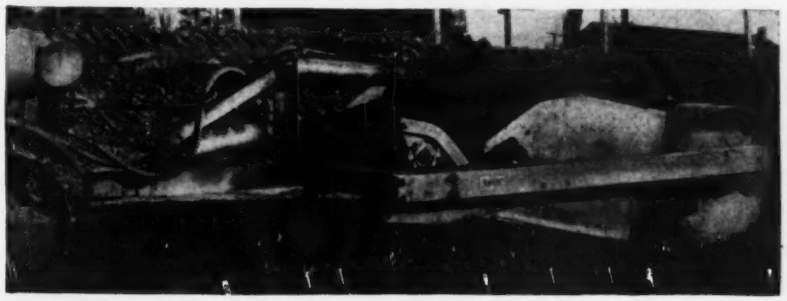


Street and road sweeper for trucks.

located in the cab. While operating the broom the driver can vary the degree of pressure of the sweeper on the road surface. A sprinkler tank of 60-gal. capacity is supported by the sweeper wheels. Flow of water through the sprinkler nozzle is controlled by a gear pump, driven from the main drive shaft of the sweeper and which pumps water only when the broom is being rotated.

Tractor-Drawn Dirtmover With Hydraulic Control

For use on grading operations involving the transportation of dirt over considerable distances the Jumbo Scraper Co., 2440 East Fourteenth St., Los Angeles, Calif., has developed the Jumbo hydraulic dirtmover, available in two sizes for operation with Caterpillar 30- and 60-hp. tractors. The smaller model has a bowl 7 ft. wide with a water measurement capacity of 65 cu.ft. It will carry a load of 2 cu.yd., and will partly carry and partly shove about 4 cu.yd. The larger model has a bowl 9 ft. wide, with a water measure capacity of 150 cu.ft. This unit will move about twice as much dirt as will the smaller one. The machines are simple in design and strong in construction. Operation is through two hydraulic cylinders, one of which governs the depth of cut and lifts the bowl, while the other dumps the load. A pump connected to the rear power take-off of the tractor provides hydraulic pressure, while control is through a special valve mounted within easy reach of the tractor operator.



Dirt-moving unit with hydraulic control.

Business Notes

THE KRON CO. is the new name of the reorganized American Kron Scale Co. Headquarters of the company have been removed from New York City to Bridgeport, Conn. Richard F. Straw, formerly with the Wright Mfg. Co., is president of the new organization. Other officers are F. W. DeFoe, H. C. Stevenson and George A. Nichols.

MEDINA IRON & BRASS CO., Medina, N. Y., has been reorganized with the following officers: William J. Kirby, president; William A. Munson, vice-president; J. D. Johnson, secretary and treasurer.

PORTLAND CEMENT ASSOCIATION announces the appointment of Henry R. Albion as assistant manager, Eastern offices, with headquarters in Atlanta.

NATIONAL EQUIPMENT CORP., Milwaukee, announces the appointment of W. J. Koehring as president to succeed his late brother, Philip Koehring.

CHAPMAN VALVE MANUFACTURING CO., Indian Orchard, Mass., has appointed Thomas F. Maher president of the company, succeeding Adolph W. Gilbert, resigned. Edwin A. Carter was elected vice-president and remains chairman of the board.

BLAW-KNOX CO., Pittsburgh, is entering the dust-collector field with two lines of equipment developed and ready for the market and other lines in process of development. M. J. Dorfan, formerly of the Pangborn Corp., has been appointed manager of the new dust-collector division of Blaw-Knox.

ALLIS-CHALMERS MANUFACTURING CO., Milwaukee, has purchased the line of graders built by the Ryan Manufacturing Co., of Chicago.

New Publications

Trade Shows—The Metropolitan Life Insurance Co., New York, has published findings of a survey of trade shows in a report, "How Exhibitors Are Meeting the Trade Show Problem." The information was contributed by 84 trade associations sponsoring national or regional trade shows. The report expresses the opinion of exhibitors in many industries that, although trade shows appear to be helpful to business, the methods of conducting them must be brought into line with today's changed conditions if buyers of space are to be assured of adequate returns.

Power Shovel Information—The Thew Shovel Co., Lorain, Ohio, has published several new pages listing corrections for addition to previous issues of the Thew Handbook. New clearance charts, additional information on clamshell buckets and loads, cable lengths, air cleaners, anti-freeze compounds and cooling, and electric installations are but a few of the items covered in the new sheets.

Anti-Freeze for Air Lines—The Sullivan Machinery Co., Chicago, has issued a new bulletin 100-C on Tanner Tanks and Tannergas. Certain improvements in detail of design of this anti-freeze system for air lines are illustrated in this eight-page booklet. Typical installations of the system are shown.

Seamless Steel Fittings for Welding—A 4-p. bulletin, 32-1, of the Taylor Forge & Pipe Works, Box 485, Chicago, contains list price and dimensional data of Taylor seamless steel fittings for welding and Taylor forge flanges.

Concrete Admixture — The Barnsdall Tripoli Co., Railway Exchange Bldg., St. Louis, had published a new 16-p. pictorial bulletin No. F, and also bulletin No. G, describing the use of Barnsdall Admix as a workability agent and integral waterproofing for concrete, mortar, stucco and cement products.

Paver—The new 1932 Rex paver, known as the Rex Roadmaker, is described in a 40-p. booklet published by the Chain Belt Co., Milwaukee, Wis.

Current Construction Unit Prices

Dredging in Miami River, Florida

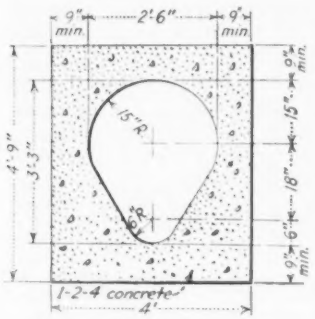
CONTRACT was let in December, 1931, by the U. S. Engineer office, Jacksonville, Fla., for dredging 1,175,000 cu.yd. from Miami River. Lieut. Col. L. V. Frazier is district engineer. Unit prices are given of the five bidders.

Standard Dredging, New York	$0.44	$517,000
Clark Dredging, Miami	.45	528,750
Robert G. Lassiter & Co., Jacksonville	.505	593,375
Central Dredging, Chicago	.588	690,900
Arundel Corp., Baltimore	.59	693,250

Concrete Sewers of Special Section in Milwaukee

TWO sewer contracts were awarded April 16, 1931, by the Metropolitan Sewerage Commission of Milwaukee, Wis., for a total of $174,516. The determining item in each is a 2½x3¼-ft. concrete sewer section shown in the drawing.

Contract 67 is for 6,659 ft. of main sewer in Riverroad, Lincoln Park, Belle Isle Drive, Riverview Drive and Ninth St. Contract 69 is for 3,400 ft. of main sewer in Hampton Road and Lincoln Creek Parkway. Excavation on both contracts is sandy clay, and depth of trench averages 25 ft.



Section of Milwaukee sewer.

Six bids were received on contract 67 and eight on 69. Unit prices are given of the two lowest bidders on each contract and the average of all the bids on each. Bidders were: contract 67, (A) Anderson & Co., Chicago, contract; (B) Wenzel & Henoch Construction Co., Milwaukee; contract 69, (A) Zimmerman & Zimmerman, Milwaukee, contract; (B) Mierswa Construction Co., Milwaukee. John Fowles is secretary of the commission.

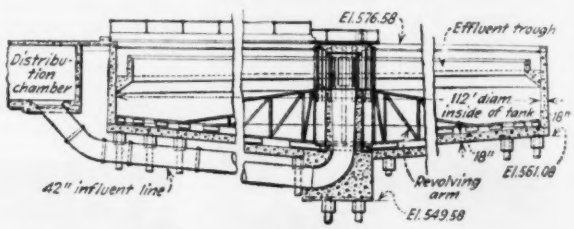
Contract 67	A	B	Avg. Six
6,659 ft. special sec. conc. sewer	$14.80	$14.36	$16.10
2,346 ft. 24-in. TC pipe in 6-in. conc. envelope	6.00	8.84	10.00
1,055 ft. 30-in. conc. sewer	6.60	9.58	10.38
492 ft. 20-in. c.-i. class A	4.90	7.87	7.85
275 ft. standard manhole	8.50	10.00	15.36
235 ft. drop manhole	10.50	17.00	19.70
Total	$126,832.50	$137,125.17	$155,300.00
Contract 69			
3,405 ft. special sec. conc. sewer	$13.39	$13.55	$16.80
70 ft. standard manhole	12.00	12.00	16.60
100 ft. drop manhole	12.00	14.00	19.60
	$47,682.95	$48,377.75	$60,500.00

Aeration and Settling Tanks for Cleveland

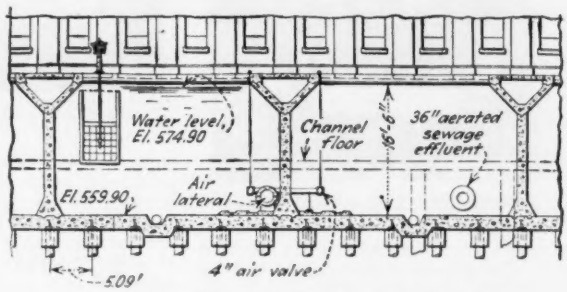
CONTRACT 73 for construction of aeration and sludge settling tanks and operating galleries for Cleveland's Easterly sewage-treatment works was let by the department of public service in November, 1931, for $2,736,874. The whole plant was described in *Engineering News-Record*, Dec. 31, 1931, p. 1034. The present contract consists of four batteries of aeration and sludge-settling tanks, each battery consisting of four two-pass aeration tanks 54x334 ft. and 16½ ft. deep; four sludge-settling tanks with sludge-removal mechanisms, each tank 112 ft. in diameter and 15 ft. deep. Operating galleries and return sludge pump room are of brick and 1,050 ft. long.

Six of 78 items account for 57 per cent of the cost. These are: excavation, $154,000; wood piles, $200,000; pile anchors, $105,000; sheetpiling, $81,000; concrete, $735,000; reinforcement, $270,000.

The piling is pine, fir, cypress or mixed hardwood timber, 12 to 18 in. at 3 ft. from butt and 6 to 7 in. tip diameter.



Revolving-type sludge-settling tank, Cleveland sewage works.



Two-pass aeration tank in Cleveland sewage works.

Concrete proportions consist of 1 bbl. cement, 6 cu.ft. fine aggregate and 12 cu.ft. coarse aggregate.

Bids were asked on two proposals: A, conveyor type sludge-settling equipment; B, revolving type sludge-settling equipment. Estimates of the fourteen bidders averaged $3,170,774 for the conveyor type and $3,107,820 for the revolving type. Unit prices of the principal materials items are given for the lowest three bidders: (A) American Construction Co., Marion Bldg., Cleveland, $2,736,874, contract; (B) E. H. Latham & Co., 447 Neilson Ave., Columbus, $2,748,528; (C) Lowensohn Construction Co., 1740 East 12th St., Cleveland, $2,797,925.

	A	B	C
495,000 cu.yd. excav.	$0.31	$0.473	$0.36
606,000 lin.ft wood piles	.33	.36½	.325
950 tons pipe anchors	110.00	78.00	89.00
1,370 tons sheet piling	59.25	74.86	70.00
71,200 cu.yd. concrete	10.32	11.87	12.10
4,730 tons reinf.	57.00	58.60	55.10
8,500 lin.ft. expansion joints	.95	1.72	2.40
Cast-Iron Pipe and Fittings:			
460 tons bell-and-spigot	72.20	55.95	64.00
40 tons flanged	99.50	71.18	82.00
300 tons grooved-end victaulic	87.50	56.70	68.50
450 tons raised-end victaulic	87.50	61.20	71.00
60 tons b. and s. fittings	175.00	120.00	150.00
155 tons flanged fittings	188.00	153.30	175.00
170 tons victaulic fittings	202.00	149.20	183.50
130 tons special fittings	189.00	144.73	175.00
C. N. I. Pipe:			
6,000 lin.ft. 1½-in.	.40½	.35	.37
3,500 lin.ft. 2-in.	.48½	.473	.54
2,500 lin.ft. 3-in.	.77	.747	.90
4,000 lin.ft. 4-in.	1.07	1.06	1.20
1,600 lin.ft. 6-in.	2.04	1.71	2.05
530 4-in. expansion couplings	2.04	1.25	2.05
400 20-in. expansion couplings	18.40	15.00	18.40
620 2-in. gate valves	8.52	8.61	10.30
570 4-in. gate valves	33.10	33.42	42.00
900 sq.ft. aluminum sidewalk doors	9.46	6.75	9.00
6,200 sq.ft. aluminum floor grating	4.50	2.85	4.20
1,200 sq.ft. vault lights	1.95	2.00	1.20